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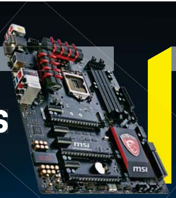

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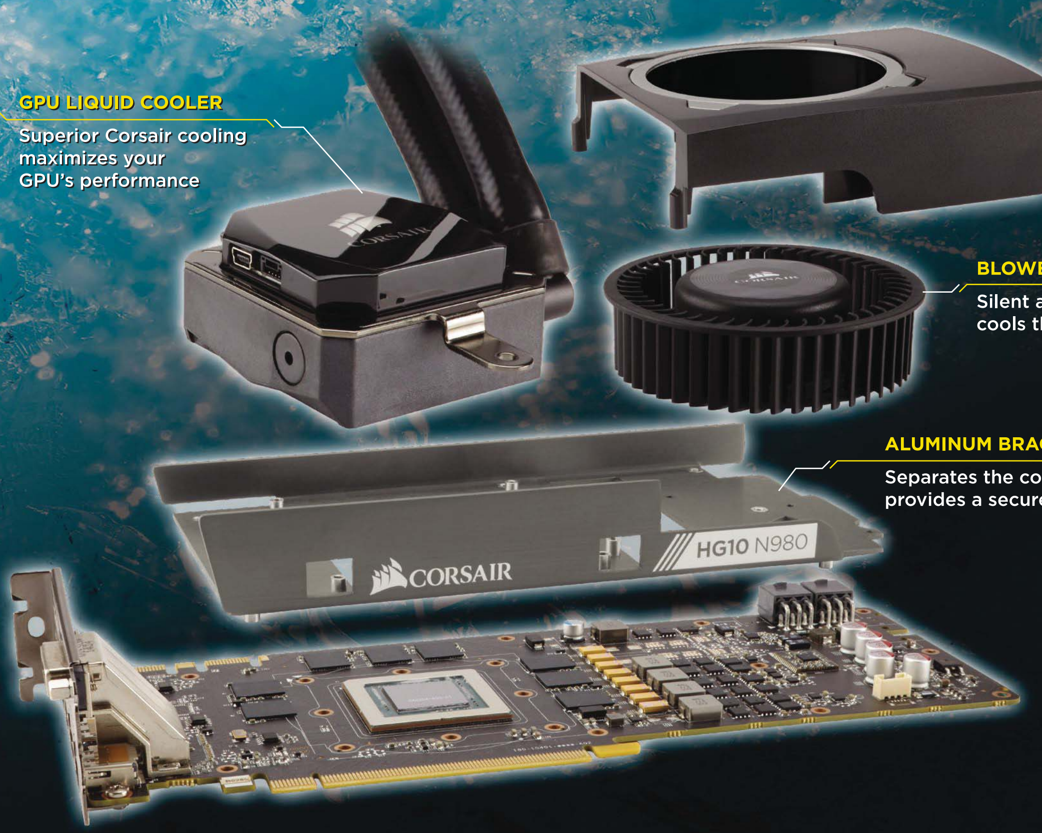
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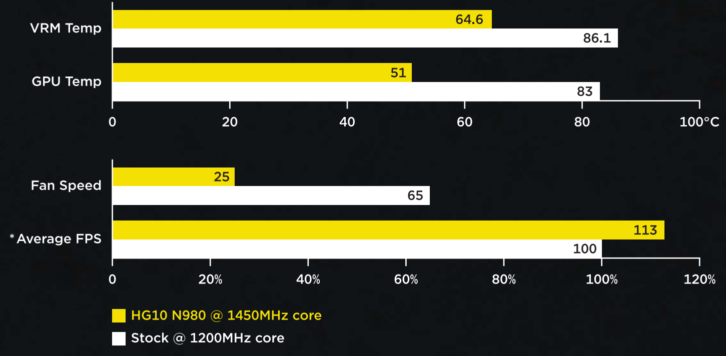

*Games used to test Frames Per Second (FPS): Far Cry 4, GRiD Autosport, Tomb Raider, BioShock Infinite at 4K max settings

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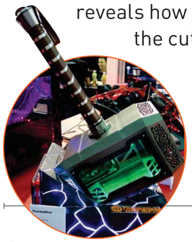

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Tuan
Nguyen

THERE'S ALWAYS ROOM FOR MORE

THIS YEAR is an exciting one for technology, and if the lead going into 2016 is any indication, your socks are going to be knocked right off. Plenty of cool demos have been given in the AR and VR spaces, plus new GPU and CPU architectures are coming out. The great news is that even the everyday things we take for granted are improving, too.

Take, for example, the ubiquitous USB interface. It's been around for what seems like forever. Without a doubt, it's the most widely used interface, spanning multiple device categories. GPU and CPU improvements aside, USB is getting its biggest upgrade in years in the form of USB-C and USB 3.1. It has a reversible connector, enhanced power delivery, and a whopping 10Gb/s throughput rate. It will even power Thunderbolt and high-resolution displays. We've got all the latest on that, plus the other new standards, and what they all mean for motherboard choices, from page 26.

But what if you're not on an upgrade path? What if you just built your PC and don't plan to upgrade it for another few years? It's more than likely that if you recently built a system, you're good for all the new tech that's coming out, but you can sure tweak the hell out of your rig. Free upgrades—we'll take those.

Sure, if your wallet is burning a hole in your pocket, you can just run out and get the fastest and greatest, but where's the fun in that? (Actually, that sounds pretty fun, too.) But in all seriousness, there's always more to gain if you're willing to just dive a little deeper into your system with settings that are already there for you. The three biggest areas of any PC that are primed for tuning are the CPU, GPU, and RAM. In this issue, from page 42, we go through the ins and outs of tweaking frequency, bus speed, ring-voltage, and how to find a stable overclock.

Personally, I've never left a product running at stock specifications. The headroom is always built in, and since each chip is slightly different from the next, there's a good chance you might land one that overclocks nicely. My Core i7-5960X? It's running at 4.3GHz, even without adjusting core voltages. Who says the frequency wars are over?

Speaking of tuning, it's been a while since I gave an update on what we're doing here at the home base. We successfully launched a brand-new *Maximum PC* website, and with it, a barrage of new content that's more squarely focused on how to do things. You may have noticed that the magazine and website now better complement each other. With the launch out of the way, we're back to the basics: content. And if content was taking just a single PCIe slot, we're about to go three-way SLI on this ship. Oh, and let's not forget to overclock the hell out of it.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 19 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Is the End Nigh for the Humble HDD?

Tumbling SSD prices mean the storage arms race is truly on

HAVE YOU CHECKED the prices of solid-state drives lately? For just over $300, you can own a high-performance 1TB SSD. It's become a surprisingly crowded field of relatively affordable options, considering that not so long ago there weren't that many SSD models boasting 1TB of storage. What's more, the ones that existed were too damned expensive to take seriously. Now, there's talk of 10TB capacity SSDs and beyond—huzzah!

Before we get ahead of ourselves, let's look at how the market's evolved over the past several years. In 2011, OCZ launched the Colossus, a 3.5-inch SSD with 1TB of capacity. It offered up to 260MB/s of sequential read and write performance, which was fast for its time, and commanded an obscene $3,300. Talk about a turn-off!

A much better option came from OCZ two years later, in the form of its 2.5-inch Octane series. The 1TB Octane model pushed sequential read and write speeds to 560MB/s and 400MB/s, respectively, but still commanded a lofty $1,100.

It took another two years (now we're into 2013) before Crucial shook up the industry with a 1TB SSD (well, 960GB if picking nits) as part of its M500 series. Crucial paired 20nm MLC NAND flash memory from parent firm Micron with a Marvel 9187 controller, for up to 500MB/s sequential reads and up to 400MB/s sequential writes, and slapped a much friendlier $600 price tag on the thing. Life was looking good for enthusiasts, but little did we know that SSDs might be just a few years away from bullying mechanical hard disk drives out of the market.

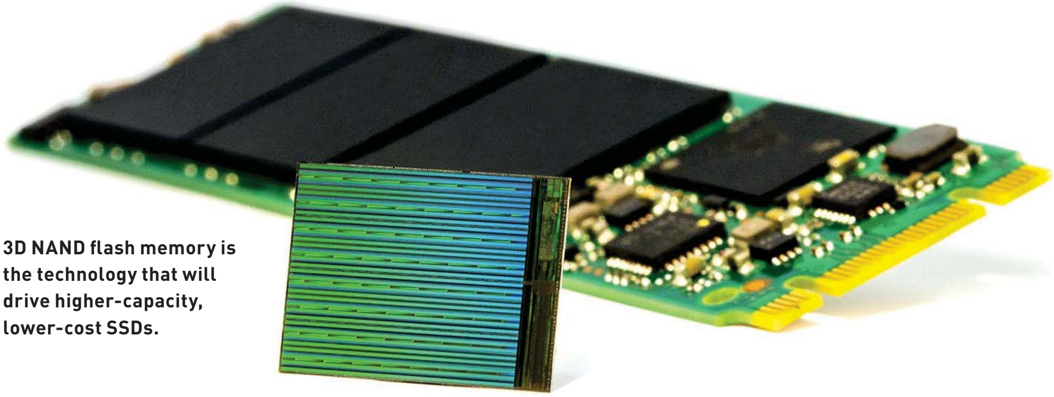
That hasn't happened yet, but it's a real possibility with the storage industry trending toward 3D NAND flash memory, which consists of vertically stacked chips that enable SSD makers to cram much more storage into the same amount of space. It also has the benefit of performing better and consuming less power. The technology has the backing of Intel and Micron, a pair of tech titans that jointly developed a 3D NAND technology that the pair claim will enable gum stick–sized SSDs with greater than 10TB capacity.

"Micron and Intel's collaboration has created an industry-leading solid-state storage technology that offers high density, performance, and efficiency, and is unmatched by any flash today," said Brian Shirley, vice president of memory technology and solutions at Micron Technology. "This 3D NAND technology has the potential to create fundamental market shifts. The depth of the impact that flash has had to date, from smartphones to flash-optimized supercomputing, is really just scratching the surface."

Indeed it is, and Intel and Micron aren't the only firms pushing 3D NAND. Samsung has been mass-producing its own 3D NAND chips since 2014, and Toshiba is constructing a new fab to do the same, starting in the first half of 2016.

It all amounts to a bit of an arms race, which will ultimately result in higher-capacity SSDs at lower price points. Meanwhile, HDDs are sitting at 10TB in the enterprise sector, but if we're counting non-consumer drives, we have to mention SanDisk's plans to release a 16TB SAS-based SSD next year. In short, SSDs are about to catch up to HDDs in capacity, while prices continue to plummet. **–PL**

> "3D NAND will enable gum stick–sized SSDs with greater than 10TB capacity.



3D NAND flash memory is the technology that will drive higher-capacity, lower-cost SSDs.

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SOURCEFORGE ADWARE ANGERS OPEN-SOURCE COMMUNITY

AFTER DRAWING the ire of the open-source community for a couple of weeks, software directory SourceForge has published a blog post explaining how it will generate ad revenue going forward. The online repository landed itself in hot water after it was found to be bundling adware with free and open-source software downloads, most notably the Windows version of the GNU Image Manipulation Program (GIMP).

In the post, SourceForge said the bundling was part of a test to see how palatable the ads would be. "SourceForge also recently ran a test of presenting easy-to-decline third-party offers with a small number (5) of projects mirrored on our site," the post continued. "This included gimp-win, but did not include nmap. We promptly discontinued this test based on community reaction."

The GIMP project took to its blog to chastise SourceForge, and indicated that the trust the community had placed in the website had been irreparably damaged: "To us, this firmly places SourceForge among the dodgy crowd of download sites. SourceForge are abusing the trust that we and our users had put into their service in the past. We don't believe that this is a fixable situation," the post said. "Even if they promise to adhere to the set of guidelines outlined below, these promises are likely to become worthless with any upcoming management change at SourceForge."

In response to the criticism and broken trust, SourceForge established a forum for its community members to share their ideas and suggestions. Unfortunately for SourceForge, that may not be enough. GIMP is already gone from SourceForge, and other open-source projects are leaving or feeling the pressure to leave, too.

A developer for Wine proposed migrating away, in a June blog post, due to: "SourceForge's recent activities with taking over open source projects for their own personal gain." You can also add elementary OS and Notepad++ to the list of open-source projects that SourceForge scared away with its adware actions. **–AC**

AT&T FACES $100 MILLION FINE

FCC SAYS AT&T MISLED ITS UNLIMITED-DATA SUBSCRIBERS

THE FEDERAL COMMUNICATIONS COMMISSION (FCC) plans to impose a $100 million fine on wireless carrier AT&T for "misleading its customers about unlimited mobile data plans." In short, AT&T is in the dock for throttling speeds to customers of its unlimited data plans without adequately notifying them that they could receive slower connections.

AT&T first began offering unlimited data plans in 2007. Four years later, the wireless carrier implemented a "Maximum Bit Rate" policy that put a cap on the amount of data an unlimited data customer could consume. Anyone who went over the data cap suffered deliberately slower speeds. While AT&T no longer offers unlimited data plans to new customers, the FCC says AT&T sold millions of unlimited plans to customers who previously signed up and chose to renew. The FCC claims it's received thousands of complaints about AT&T's throttling since the policy took effect. **–PL**

PRE-ORDER YOUR STEAM MACHINE

The wait is finally over

AFTER A NEARLY TWO-YEAR WAIT, you can finally pre-order a Steam Machine, along with a Steam Controller and Steam Link, a device that taps into your home network and streams your library of Steam titles to your TV. Dell's Alienware division rolled out four Steam Machine models, ranging from $450 to $750. The highest-end SKU features a Core i7-4765T quad-core CPU, 8GB of RAM, an unspecified Nvidia GeForce GTX GPU, 1TB hard drive (7,200rpm), built-in wireless connectivity, and a Steam Controller.

CyberPower's Syber Gaming arm was the other boutique builder to jump on the pre-order bandwagon, with three models, ranging from $499 to $1,419. Its top dog pairs a GTX 980 with a Core i7-4790K, 1TB HDD, and 16GB of RAM. These systems also feature Wi-Fi connectivity and come with a Steam Controller. **-PL**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

LESS LEGAL SPEAK, PLEASE
Microsoft vowed to simplify its privacy and service agreements by using more plain English.

A MORE SENSITIVE MOUSE
Razer's new flagship Mamba mouse for gamers boasts a 16,000dpi laser sensor that can be adjusted in 1dpi increments.

STEAM SETS A RECORD
Back in June, Steam had over 10 million users logged in simultaneously, breaking its previous concurrent user record of 9.5 million.

TRAGEDIES

HACKERS HIT LASTPASS
The password manager suffered a breach, meaning all users had to change their master passwords.

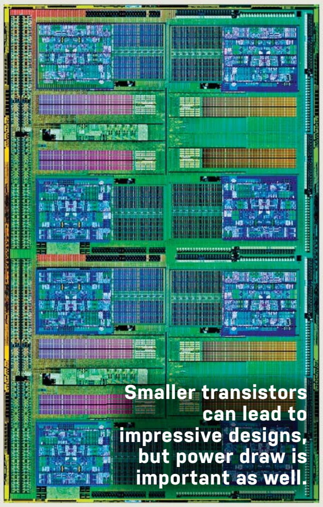
VPN GONE WRONG
Peer-to-peer VPN service Hola angered users of its free service when it inadvertently sold their bandwidth to a botnet operator.

GAME OF PIRATES
Game of Thrones set a BitTorrent swarm record with over 258,000 pirates seeding and leaching the show's Season 5 finale.

Tom Halfhill

FAST FORWARD

Watts Up With Processor Power?


Smaller transistors can lead to impressive designs, but power draw is important as well.

MY RECENT COLUMN on AMD's advanced voltage/frequency scaling confused some readers. It's worth tackling this subject again, because power consumption is the most challenging problem for chip designers.

It's also a challenge for users who struggle with thermal requirements when building custom systems. The root problem is that each new generation of chip-fabrication technology enables smaller transistors, so designers cram more of them on each chip. It's great for processor performance, because we get more powerful CPU cores, more cores per chip, and more cache. That's the bright side of Moore's Law. The dark side is power consumption. Although today's transistors are extremely power efficient, their wattage adds up when a chip has billions of them.

Most home users could afford to pay the slightly higher electric bills if their PCs consumed twice as much power. For data centers with thousands of rack servers, the higher bills would be more deadly. But heat dissipation—the corollary of power consumption—is the real killer.

In the early 2000s, chip designers hit the "power wall." No longer could they gain performance simply by cranking up the clock speed. Chips were getting so hot that they stopped working. So, designers found alternatives, such as spreading the software workload across multiple CPU cores. Other power-saving techniques are dynamic voltage/frequency scaling (DVFS) and advanced voltage/frequency scaling (AVFS). Both work on the principle of reducing the processor's supply voltage and clock frequency when full speed isn't needed. But the commonly used power equation I quoted ($P=fV^2$) confused some folks. It says that power varies linearly with clock frequency and quadratically with voltage. For example, reducing the frequency by 50 percent also reduces power by half, but reducing the voltage by 50 percent reduces power by 75 percent. Voltage matters more than frequency because it's a squared factor.

You can't use this equation to calculate actual processor power, however. (For one thing, I deliberately omitted a capacitance factor to more clearly show the voltage/frequency relationship.) So, if your 1.2V processor runs at 3GHz, you can't multiply 1.2 x 3.0 to find the wattage. The simplified equation merely expresses the *relative* voltage/frequency relationship.

Also, the frequency factor doesn't apply to other things. One reader joked that his desk lamp would burn 864,000 watts because it uses 60-cycle alternating current at 120 volts. Luckily, AC frequency isn't the same as processor clock frequency, or we'd still be burning candles.

DVFS is getting more complicated as designers divide their chips into more power, voltage, and frequency domains. Instead of varying the entire chip's voltage and frequency, individual sections are controllable. Some domains can vary their voltage; some can vary their frequency; some can vary both; and some can shut off their power altogether. One company (Sonics) recently announced a power-management subsystem that can do all this stuff for dozens or even hundreds of domains. The trick is to vary these factors on the fly without noticeably hurting performance.

"Dark silicon" is a popular industry buzz term. It means that more circuits in your processor will power down when they're unneeded, spring to life when duty calls, and then go "dark" again to save power. It's like switching off the lights in your home's unoccupied rooms, except it happens automatically, many times per second—and if it's done right, you won't notice a thing.

> The dark side of Moore's Law is that while today's transistors are extremely power efficient, their wattage adds up when a chip has billions of them.

Tom Halfhill was formerly a senior editor for *Byte* magazine and is now an analyst for *Microprocessor Report*.

CyberPower recommends Windows.

AMD

AMD RADEON GRAPHICS

AMD FX UNLOCKED

AMD A SERIES

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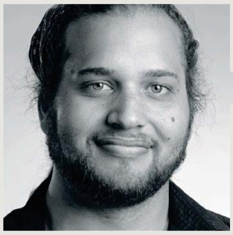


Alex Campbell

OPEN SOURCE

Why No Linux Boxes?

I WASN'T MENTALLY PREPARED FOR E3. Not as a journalist, and not as a Linux user. When the doors opened at noon, the floor was filled with the multitudinous denizens of the video game industry. About half of the tech journalists, too, while the other half crowded the media lounge for a chance to sink their teeth into the provided box lunches.

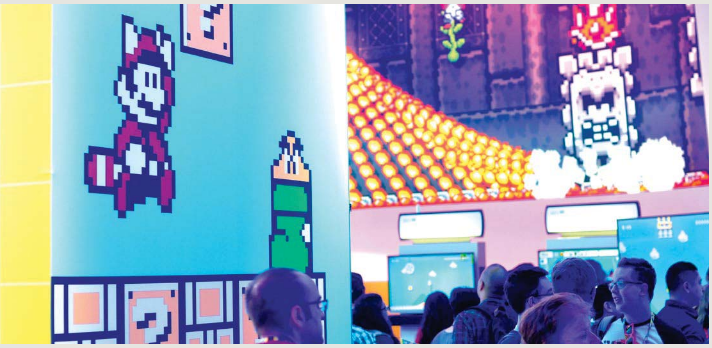
This was a good move on E3's part; it could've been a bloodbath had they turned on one another instead.

I immediately noticed the unstoppable force that is the console market. The Nintendo, Xbox, and PlayStation booths were unrivaled in the LA Convention Center. The big three consoles call the shots at E3, and they make it blaringly obvious. It felt dirty. It made me want to cower naked in a cold shower, sobbing uncontrollably while rubbing videocards on my body. Seeking the comfort of a keyboard, I set out to find a Linux machine at E3. In three days of searching, I saw exactly zero.

Did I see PCs? Sure. Oculus had PCs running Rift demos, and there were even PCs set up at the Bethesda booth. My hopes were renewed when I discovered Alienware had brought a Steam Machine, but it was tucked away in a meeting room.

At E3, you'd think there would be more Steam Machines on display—they're supposed to be such a big deal this fall. Yeah, not so much. That's a problem I see with Linux: It's not visible, and is thus disregarded by developers. Steam even states that Linux is Valve's preferred OS, but you'd never know it given the disparity between the major titles available for Windows versus Linux. Every store I go into has laptops with Windows 8. I don't think I've ever seen a laptop in BestBuy preloaded with Ubuntu.

But these makers exist. Firms such as Zareason and System 76 have been building Linux machines for years. Purism's Librem 13 looks as handsome as my Yoga 2 Pro, but without the compatibility issues. Hell, even Dell released a "Developer Edition" of the XPS 13 that's sporting Ubuntu 14.04 LTS.



Nintendo's white and pastel-lit booth was the least garish of the consoles.

These products, despite providing a chance to avoid the Windows tax, remain hidden from most consumers. Dell's Ubuntu version of the XPS 13, for example, isn't on the model's main landing page, but on a page for businesses. And, as good as the machines might be, System 76 and Purism aren't household names like Lenovo or Toshiba.

Most consumers don't want to have to wipe a drive and start from scratch. They want to turn on a machine and have it work right away. After all, that's what consoles do. (Oh, God, I need another shower.) Desktop Linux needs hardware partners. It needs companies like Dell to advertise its Linux options alongside its Windows options. It needs to stop being treated like a second-class citizen, only being allowed to enter through the back and eat with other open-source kernels.

After all, choice is good for the consumer. When users are shown they can have freedom, and avoid the $100 Windows surcharge, many (but by no means all) will choose freedom.

That's why I was a little upset not to see any Steam Machines at E3. Or maybe it's because when I said, "I write about Linux," to a young woman at a *Call of Duty: Black Ops 3* promo booth, she looked at me like I was explaining orbital mechanics. I don't blame her, I blame the hardware market. At least I got some free T-shirts.

> “It made we want to cower naked in a cold shower, sobbing uncontrollably while rubbing videocards on my body.

Alex Campbell is a Linux geek who enjoys learning about computer security.

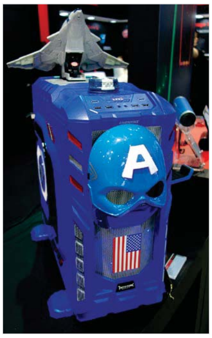
THE LIST

THE 9 CRAZIEST, COOLEST THINGS AT COMPUTEX

9

DATURE STRAMONIUM DATURA L

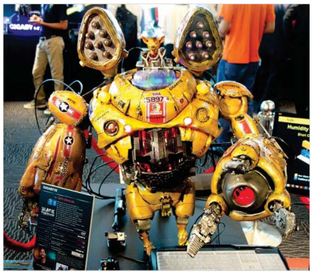
There are two PCs using the same closed-loop cooler here.



8

CAPTAIN AMERICA PC

This Thermax Giant is what the Avengers game on.



7

MACIEL BARRETO PC This Gigabyte-sponsored mod looks like a PC out of *Titanfall*.

6

MASTER CASE

Cooler Master's new case is built on the premise of extreme customizability.

5

ACER'S TRIPLE PREDATOR X34 SETUP Ever play in 11K?

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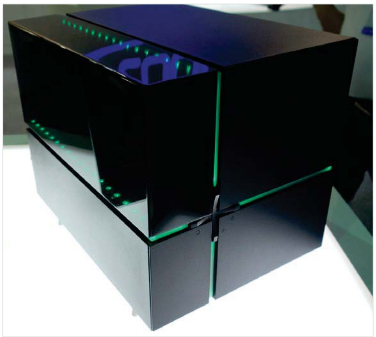
GEFORCE GTX 980 Ti
NVIDIA G-SYNC
acer
NVIDIA

4

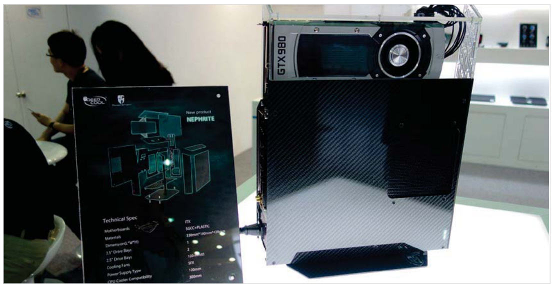
UNNAMED

This Deepcool case looks like a computer from the future.



3

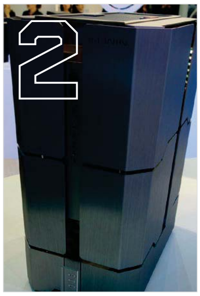
NEPHRITE Deepcool's Nephrite looks like a custom-made carbon fiber PS4.

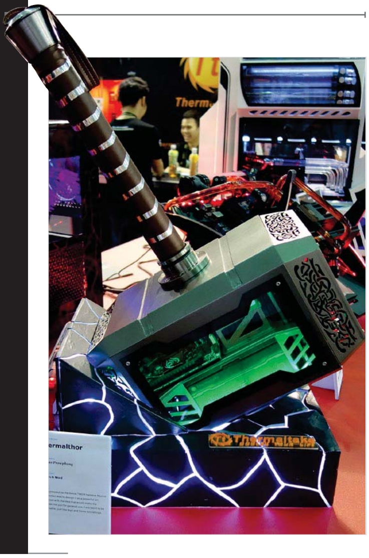

GTX980
NEPHRITE

TRANSFORMER

In Win's case transforms and opens up. It's the craziest case we've ever seen.

2





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TALKING

BY **DANIEL GRILIOPOULOS**

How Razer Sharpens the Cutting Edge

MPC chats to Min-Liang Tan: eSports pioneer, tech visionary, and founder of kit-maker Razer

When Min-Liang Tan started in eSports, it was a tiny field. In 2015, it's huge and only getting bigger. When he started making luxury peripherals, he was a pioneer. In 2015, every hardware firm does it. Min's an important man to talk to, not merely because he makes incredible computer mice, but because he's always cared about staying on the cutting edge—and Razer's recent billion-dollar valuation from Forbes reflects that.

Tan's fear is that he'll keel over just before the Singularity arrives.

Maximum PC:
You're from Singapore. How did growing up there change your life and help set you on this path?

Min-Liang Tan:
Gaming was pretty much frowned upon. The focus over there is all about academia, doing well. Gaming is more like a waste of time. But I've always been passionate about gaming, right from the get-go. It was close to Korea, so [Korea] gave me the opportunity at first, really early in the inception of pro gaming. Back then it wasn't called eSports. It was called professional gaming. I spent a lot of time in Korea.

MPC:
And you go back to Singapore and people are like: "You could play games *and* make money?"

MT:
Yeah, it was a little odd, but I enjoyed gaming. I then went over to San Francisco, hung out with a buddy who was part of the clan—back then we were called clans or teams and stuff like that. After that, guilds, and then everyone would have their names in little square brackets. But yeah, things have changed. That was pretty much the progeny. I used to be a huge competitive *Quake* and *Unreal* player.

MPC:
Nowadays, your company is all over the globe, isn't it?

MT:
I spend half the time in San Francisco and the other half in Asia. I go back and forth every month. In fact, just before this, I was in Singapore. We've got a tech center, in Boston, and we've got three design centers, in San Francisco, Singapore, and Taiwan. We manufacture in China. That's where they have the best manufacturing today. Because all manufacturing is sent to China, you probably get the best manufacturing robots and stuff like that out there.

MPC:
Eventually, you shifted from being a pro gamer to product creation. Was there any reason or philosophy behind the change?

MT:
I love gaming, it's good fun. I think over and above, it's having no compromise in the products

The Mamba is the latest rodent from Razer, and boasts a 16,000dpi sensor.

that we make. The Blade laptop is a great example. I wanted a laptop for myself and there were no laptops out there that met my requirements. All the gaming laptops used to be really thick and heavy, and powerful, but I wanted something that was thin, light, and insanely powerful, but super portable at the same time.

I remember going to every single laptop manufacturer and they said it's impossible. We figured out it wasn't. We hired some of the best thermals engineers, we acquired a team that made super-slim form factor PCs back in the day, and we built this. I mean, it's having a no-compromise approach to designing product. That's something I'd rather focus on.

MPC:
So, when people tell you something is impossible, you don't really listen?

MT:
Yeah. It's a little bit like that. We've heard it too often. Back in the day, when it was the first gaming mouse, they would say, "Nobody would want this." We said, "I would want it for myself," and we just went ahead to do that.

You know that certain things are possible despite somebody saying to you that it's impossible. You just go ahead and do it. I don't know if that contributes to a philosophy of life.

MPC:
It does, to a degree. You've taken precision engineering and used it in the service of happiness. That's your way of making the world a better place.

MT:
I think it started off just on a fun perspective. It grew into a life of its own that today Razer has become a platform of sorts, for us to evangelize about gaming.

I spent so much time being told that gaming is a waste of time that it's become a little bit of a mission. There's nothing wrong with having competitive fun. This "for gamers by gamers" motto is more serious than it may seem. We want to evangelize this gaming subculture. We want to make it a living for some people from an eSports perspective, or to be able to show that gaming is pushing the envelope of technology forward. Like processing power. Who needs more processing power? Gamers. But what does it contribute to at the end of the day? It sends people to the Moon, to Mars.

MPC:
You set up a firm of engineers and artists, but no one gets told they're worth a billion without being a good businessman.

MT:
I think what's different is that we're quite open. I posted it on Facebook to say, look, we make great profits. The difference is, they don't flow into the pockets of shareholders, they all go back into R&D. That's why it allows us to keep moving forward.

People say, "Can you do something cheaper for us, like dumb down some of the features?" I say, yes I could. But would I? No, because after I'd dumbed-down those features, it comes at a lower price point. That's not a Razer product anymore. A Razer product to us is a no-compromising, all-encompassing incredible experience for all gamers. That's one of those things I tell the engineers all the time—if we cut corners at any point, even though nobody might know it, you would know it in the middle of the night.

It's a horrible life to be at Razer because every product, you're going to be constantly berating yourself—what could we have done better?—over and over and over again. There's always new technology that allows us to make it better. It's the constant pursuit of perfection that you know will never be achieved.

MPC:
What's happening with your modular PC, Project Christine?

MT:
We're working on that, but the thing about Project Christine is that it's one of those things that needs industry recognition. We've been open to everyone else out there to say, "Look, you know we're happy to have this license for free to everyone out there." We don't even want to make money.

The thing is this, it goes against the grain of a lot of standard things, like it stops wastage. You just have to change the modules that you need to change. You could go into a subscription module method. Does that work for current companies? No. It reduces their revenues dramatically. That's something that while it's a great idea for a product, it goes against the grain of business. But is that holding Razer back? No. At some point of time we're going to get so much, much larger. We may be able to push Project Christine by ourselves. That is not to stop us from killing our own business models. It doesn't. But we want to do cool stuff. *That's* what is important.

MPC:
The names of your products, such as Deathadder and Mamba, are very aggressive. But the codenames are always really soft, like Fiona or Christine. Is there a reason for that?

MT:
This is a funny story. In the early days, we wanted the engineers, or whoever came up with an idea, to have a personal connection [to its development]. So, anybody who came up with a killer idea would be able to name it after a special person in his or her life.

However, we decided that if you could only name it after your girlfriend, or your spouse, or whoever, it would limit you to only one special product. So we said, "No, you can only name it after an ex-girlfriend or someone special in your life," so that you'd at least have a couple of ideas.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> GPU Backplates
> Excessive Power?
> Multiple Monitors

Updating Storage

Doc, I own a Samsung EVO 250GB SSD, which *Maximum PC* recently identified as having new firmware to alleviate memory/performance loss. After upgrading my Samsung Magician suite, the software detected the update, but failed to install it. After a little research, it appears the AMD chipset (990FX) on my Asus motherboard and the Samsung firmware utility are at odds. Supposedly, there is a newer AMD SATA controller driver, but I'm unable to locate it. It isn't on Asus's website or AMD's. I'm at a loss. I wrote to Asus and its customer service told me to flash my motherboard's firmware to version 2501, which I already have. **–Steve M**

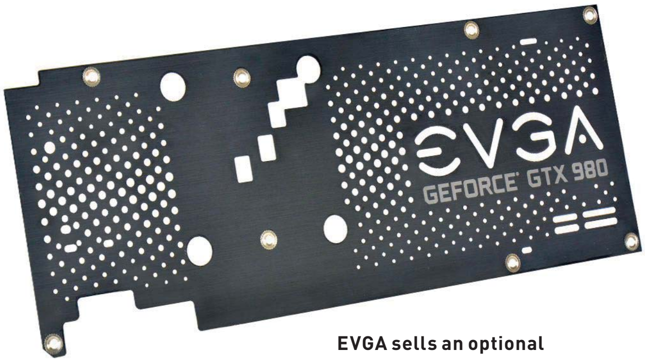
THE DOCTOR RESPONDS: It sounds like you've done a fair bit of research already, Steve, so hopefully this gets you to where you need to be. Head over to http://bit.ly/1eiYpgr, scroll to the bottom, and on the right-hand side you should see "AMD Chipset, AHCI, USB 3.0 and RAID drivers." Choose either the 64- or 32-bit package, and away you go.

Four For One

Love your column! I have a few questions for you. You helped with my decision to buy an EVGA GeForce GTX 980 SC because it vents out the back of the computer. It didn't come with a backplate, but you can buy one from EVGA. Will this extend the life of the card? The 980 is also G-Sync-capable. It sounds great on paper, but can our eyes really tell the difference between 60 and 144Hz? I've a Core i7-2600K at 4GHz+, with 8GB (4x 2GB) of DDR3, in an Asus P8Z77-V Deluxe motherboard in dual-channel mode. Is it better to have two sticks instead?

Finally, I've been using SSDs for a few years. My system boots from a 256GB Patriot Wildfire and I love the speed. But it's really temperamental with my favorite game, *World of Tanks*. Last time there was a 6GB update, it wouldn't install and I'd lose the download. I installed the game to my WD spinner and haven't had a problem since. My brother was having a similar problem, solved by a mechanical disk. Is it the SSD or *WOT* causing these issues? **–Bart Cubbage**

THE DOCTOR RESPONDS: Always happy to help, Bart. That backplate won't necessarily make your card last longer. It does help draw heat away from the memory modules on the back of the PCB. However, in the Doc's conversations with Nvidia, it's apparent the plate's purpose is largely aesthetic. It can actually be a detriment to cooling performance for folks with two cards in SLI right next to each other. Fortunately, your board's PCIe x16 slots are three spaces apart. If you like the way it looks, you have the Doc's blessing to buy it.



EVGA sells an optional backplate for its GeForce GTX 980, which helps draw heat away from memory modules mounted on the back of the card. More than anything, though, it's an aesthetic addition.

As far as G-Sync goes, the technology improves several aspects of gaming. In short, you'll see the biggest benefit from G-Sync at frame rates under 60. If you also own a high-refresh rate monitor, G-Sync will continue to eliminate the stuttering that happens with VSync turned on (and the tearing between frames with it off)—the effect is just less pronounced.

The Doc wouldn't recommend changing out your memory just to consolidate, unless you're upgrading to 16GB or more. Fewer modules can help with overclocking and/or more aggressive memory timings. You aren't going to see a difference in the real world.

Finally, there's no technical reason why *World of Tanks* wouldn't run on your SSD—to the contrary, it appears an SSD may improve its performance. Is your drive full to the point that there wasn't enough free capacity to download, extract and install the patch?

Storage Setup

Doc, I built a computer a couple of years ago. The case turned out to be defective, with its USB 3.0 interface shorted. When I tried to plug a thumb drive into it, everything shut down. The

↘ submit your questions to: doctor@maximumpc.com third-party controller was fried, and I've had to live with it since. Z77 boards are getting hard to find, so I ordered an ASRock model from Newegg before they are gone. I'm still deciding on a case. The question: Should I set the BIOS to AHCI before I install the boot drive? It's a SanDisk 120GB SSD. Any pitfalls to look out for during the swap?

–Bill Kirchmeyer

THE DOCTOR RESPONDS: If you're going from one Z77-based board to another, Bill, the swap should be fairly easy. Typically, these operations go sideways when the chipset vendors are different, old graphics drivers aren't properly cleared off before switching from one vendor to another, or storage is misconfigured. Maintaining the same hardware means the requisite software will mostly be resident. Third-party controllers might vary between the mobos. However, don't expect any of them to be show-stoppers. Simply install their driver packages once you're back up and running.

Is your SSD currently set up to use AHCI? If so, that's the route to go. There are ways to toggle between IDE and AHCI, forcing Windows to load one driver or the other at start-up. But you won't need to if you start and end with this more modern mode.

Barrier To Entry

My HP 210 G1 needs some help! HP says an SSD has not been "qualified" for it, so adding one will void the warranty. Is there usually something in a laptop like mine that prevents installing an SSD? I'm willing to accept some risk, but I don't want to screw things up.

–Art Hudson

THE DOCTOR RESPONDS: Many notebook vendors do employ whitelists to restrict the add-in cards their systems support (typically Wi-Fi cards). However, the Doc has never encountered an issue with SATA-based storage. You're going to be pulling out a 320 or 500GB disk, according to HP's datasheet, and replacing it entirely. If your existing partition fits on the SSD, consider a model that comes bundled with cloning software. Else, you'll need to start over with a fresh installation of Windows—not always a bad thing, but more labor-intensive.

Right-Sizing Your PSU

Hey Doc! I'm currently saving for a new PC. I've purchased an NZXT H440 chassis and Corsair RM750 PSU. Next, I plan on buying an Intel Core i5-4690K, a 256GB SSD, a 1TB hard drive, and a GeForce GTX 970. Is the 750W supply too much? If so, will it damage my system? Thanks! **–Benji Smith**

THE DOCTOR RESPONDS: Although you don't need 750W of output to power those parts, you certainly won't hurt anything by using the RM750, Benji. Think of the supply's rating as a ceiling; anywhere under 750W, it'll take good care of you. In fact, because the RM750 includes a feature called Zero RPM Fan Mode, there's a good chance that, most of the time, it won't get hot enough to require active cooling, meaning it'll operate silently.

Let's say you're running a theoretical application that taxes all of your hardware simultaneously. You'll be well under 300W of power consumption. Add a second GeForce GTX 970 in SLI if you want. Overclock your CPU and GPUs within the limits of air cooling. That 750W PSU still has more than enough headroom.

Output Alphabet Soup

Dear Doctor, I got myself into a pickle when I bought new video card: EVGA's GeForce GTX 980 Superclocked. The card supports up to four monitors across one HDMI, one DVI, and three DisplayPort connectors. I'm currently using two Asus VS229H-P monitors, each equipped with one VGA, one DVI, and one HDMI connector, but no DisplayPort. They're attached using DisplayPort to HD male adapter cables. I want to add a third and possibly fourth monitor, but want to know what's better between DisplayPort, DVI, or HDMI. I cannot find any tests to guide my choice. Would you stay with the current setup, change the cables to DisplayPort to DVI, or buy new monitors that support DisplayPort and use that interface from end to end? Please help! **–Jerry Franco**

A 750W PSU such as Corsair's RM750 can power devices reliably up to its rated limit. Under that ceiling, you'll only see efficiency vary based on the load you apply.

Nvidia's newest GeForce cards give you five output options that can power up to four monitors simultaneously.

THE DOCTOR RESPONDS: If you like your monitors, there's no reason to replace them. In fact, four of those VS229H-Ps would look nice lined up on a desk. You will, however, have to work around the different outputs offered by EVGA's card and the display's inputs.

In this specific application, there's no real reason to favor DVI, HDMI, or DisplayPort. All three interfaces support the panel's native 1920x1080 resolution at 60Hz. HDMI will carry an audio signal to the 3.5mm mini-jack, if you plan to use headphones. So, feel free to keep your existing screens hooked up the way they are. Add a third using the DVI cable that Asus bundles with its VS229H-P. And, should you decide to try a fourth, go HDMI to HDMI or connect a third DisplayPort cable adapting to either DVI or HDMI.

The Age-Old Question

Hey Doc, I'm looking for a relatively inexpensive upgrade to my current GPU, but I'm not sure if it'd be better to just start a new rig. I currently have a Core i7-3770 running Windows 7 64-bit with 32GB of RAM on an Asus Sabertooth P67 mobo. The whole configuration is backed by a 750W PSU. My current graphics card is a Radeon HD 6870, and it's definitely the low performer in my build. I had a second card running in CrossFire, but was having heat problems due to limited placement options for my PC. Is there a decent upgrade for me?

–Berek Marcus

THE DOCTOR RESPONDS: Relatively inexpensive is... well, relative. What the Doc will say, though, is that you're rocking a powerful platform. A meaningful overhaul would be pricey. Assuming you're already enjoying the benefits of an SSD, replacing the 6870 would be the next logical upgrade. It sounds like you're especially sensitive to thermals, Berek. If the sub-$200 range sounds reasonable, Nvidia's GeForce GTX 960 would serve up a notable speed-up in your favorite games. Its 120W TDP is quite a bit lower than the 6870's, too.

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The High-Bandwidth Bomb

The PC platform, and motherboards in particular, are about to drop a bomb on your desktop

by Jeremy Laird & Zak Storey

IN THE FUTURE, motherboards will be all about bandwidth. Actually, they already are. That's because the big news for the PC is a whole bunch of new interconnects. And they're all about boosting bandwidth. They're also borderline baffling. Firstly, there's the crazy nomenclature. Whoever thought that "SFF-8639" was a keeper needs to be strung up with SATA cables. More on that later. The confusing naming, that is, not death by middling-bandwith cable connects.

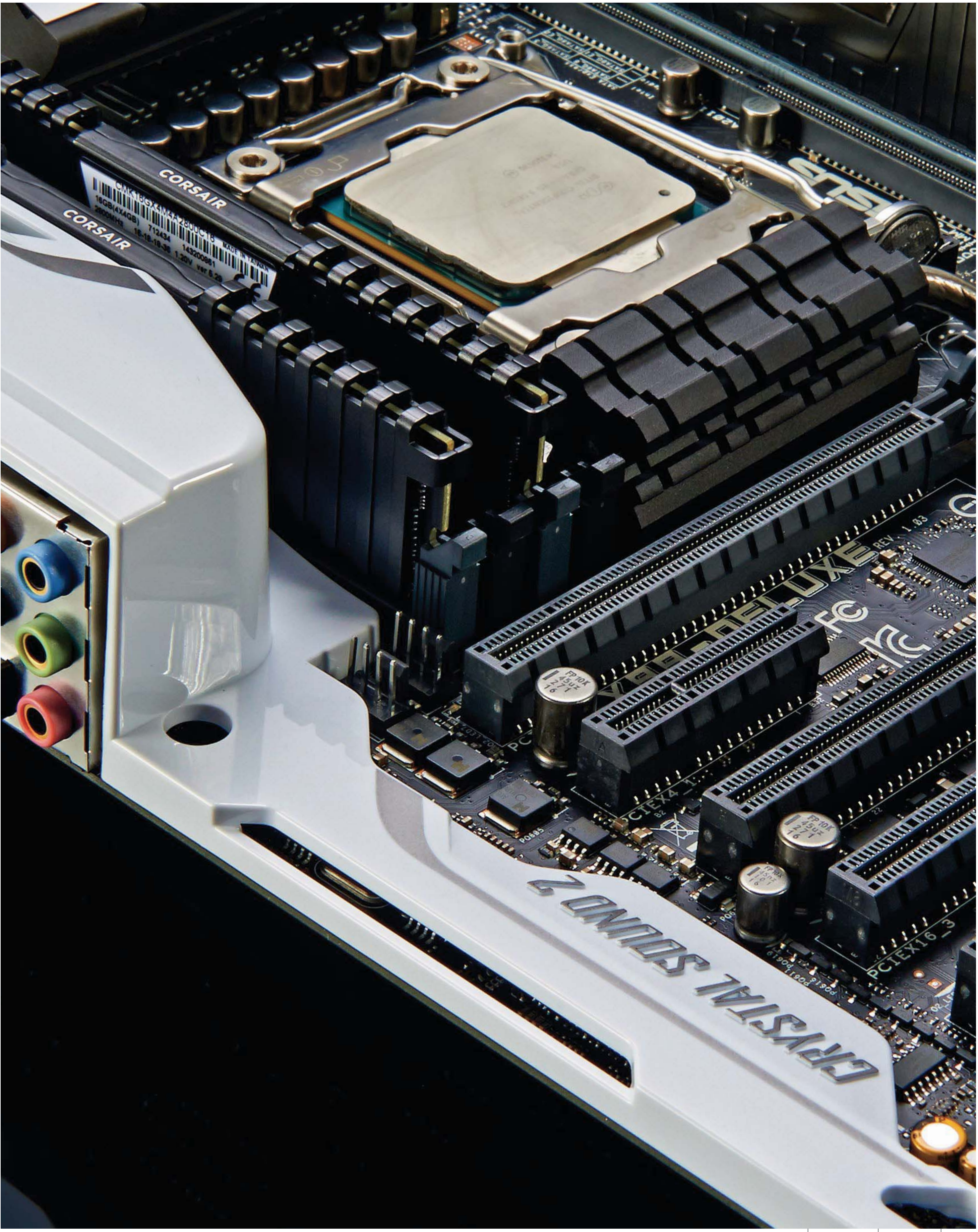
Then there's the fusing of multiple standards into one, plus the replacement of others with multiple options. Nightmare.

Maybe it was always this way. Perhaps our spectacles are growing ever more rose-tinted. Until recently, it was just PCI Express for graphics, SATA for hard drives, and USB for the rest. Wasn't it?

OK, we had to keep up with little upgrades, but now? Now there's M.2, which is a sort of PCI Express for SSDs, not forgetting that it'll need to be of the NVMe variety to really deliver next-gen performance. AHCI won't cut it. Unless it's SATA Express, which is a bit like a fusion of PCI Express and SATA. Except nobody is using it, and it looked like SFF-8639 will be the thing, until they re-named it U.2.

Meanwhile, USB 3.1 has been tweaked into USB 3.1 and USB Type C, at the same time as assimilating Thunderbolt, which may not live on as a standalone, er, standard. Yup, it's a cluttered-up mess.

This month, then, we have an all-encompassing guide to these new standards—what they all mean, how they work, whether you'll want 'em, the works. Then we'll round up the latest mobos and sniff around the actual implementation of these new standards, even though not all are fully available, and, in some cases, compatible devices barely exist. Confused enough? Let's get cracking.



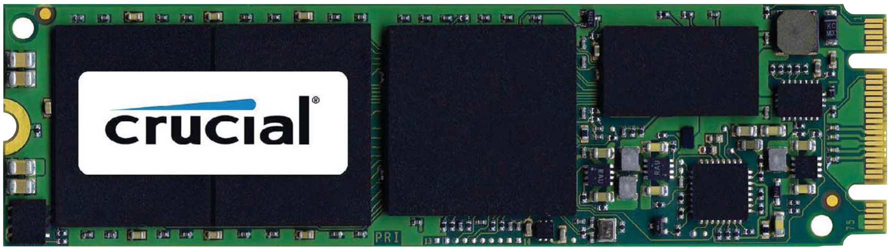
A bit like the One Ring, USB Type C has a slight problem with megalomania—it wants to own other interfaces, too

Let's start with USB. It's the mother of all modern interconnects. To say that USB has been a huge success is something of an understatement, to say the least. USB has become the very definition, the Platonic form found hanging in the intergalatic ether, of utter, crushing ubiquity.

What began in 1997 as something to make it easier to plug stuff into PCs has ballooned into the default wired interface for almost anything digital. Charging, connecting, communicating. If it's done over a wire, it's probably USB.

USB has also historically majored in maximum backward compatibility, both in terms of the physical format and the digital signaling. It's been revised several times in the name of boosting bandwith from the original 1.0 spec to today's 3.0. That's involved a journey from 12Mb/s at launch, through 480Mb/s for USB 2.0, 5Gb/s for 3.0, and latterly, 10Gb/s for USB 3.1.

What hasn't changed is the familiar rectangular socket. Throughout the bandwidth bump cycles, that has remained. Indeed, older devices could plug into revised sockets and function fine, though obviously the lowest common denominator prevails—device or host will default to the slower of the two.



Above: Initially optimal for portable PCs, M.2 is now a common desktop storage interface. Top of page: Type C USB connectors will be compatible with Thunderbolt.

Of course, USB has acquired a few frills over the years. Mini and micro sockets for smaller portable devices have appeared, and the standard rectangle "A" connector has also been accompanied by the squarer "B" interface, the latter being familiar as the interface used most commonly to hook up multi-port USB hubs.

When USB 3.0 appeared, the standard got its first electrical upgrade, too. The pins and wires went from four plus a shield, to nine plus shield. The plastic internals of the female sockets were also colored blue to help aid identification. But the new physical interface was cleverly designed, so backward compatibility was retained.

With the introduction of USB Type C, however, the near 20-year run of backward compatibility will be broken. But for some pretty decent reasons. First up is ye olde bandwidth. Developed at around the same time as USB 3.1, Type C supports all 10Gb/s of USB 3.1. Yay.

The other raison d'être is simplicity. Like Apple's Lightning and also the Thunderbolt interface, it's reversible. In other words, you can whack it in without worrying whether you've got it the right way up. That sounds like a minor convenience. But if you're fumbling around behind a PC in the dark, for instance, it's a fairly significant boon to be able to just ram it in.

LORD OF THE INTERFACES

Even better, Type C is good for both devices and hosts, putting an end to the Type A and Type B dichotomy. It's also miniscule in terms of its physical proportions; it's much, much smaller than the ubiquitous Type A rectangle. So, it's as good for desktop gear as it is for mobile hardware. Think of it as the One Ring of USB. It'll rule them all. Actually, a bit like the One Ring, USB Type C has a slight problem with megalomania. It wants to rule more than just USB. It wants to own other interfaces, too. Perhaps that's not very fair. What's really happened is that Intel's third revision of its Thunderbolt interface includes a USB 3.1 controller and is compatible with the Type C connector.

That's an intriguing proposition because it means you can have all the benefits of USB and Thunderbolt in one interface. From USB, you get the broad compatibility and some decent speed. From Thunderbolt, you get some seriously sexy new goodies.

The first is DisplayPort support. That means you can hook up all kinds of cutting-edge monitors and displays to what is a general-purpose interface. Then there's PCI Express support, which is handy for external drives, but also opens up options for running external graphics cards.

Thunderbolt 3 also ups its bandwidth ante to fully 40Gb/s. Consider, if you will, DisplayPort, USB 3, and PCI Express over a single Thunderbolt port. Nice. Beyond Apple's MacBooks, Thunderbolt hasn't gained much traction to date. But aligning it with USB Type C will almost certainly change that.

Of course, much of this technology hasn't reached existing motherboards, or PCs generally. But there have been plenty of changes when it comes to storage interconnects. Very soon after the introduction of the first solid-state drives, it became clear that the SATA standard wasn't going to be good enough.

At first, it was a simple bandwidth issue. In practice, the fastest SATA 6Gb/s iteration tops out at around 550MB/s. That's nice compared to magnetic drives of yesteryear, but pedestrian in an age of solid-state componentry and GB/s of system and graphics memory bandwidth.

More recently, it's become clear that the AHCI protocol that PCs use to control hard drives is suboptimal for SSDs. The solution, as it turns out, is PCI Express. Unfortunately, the solution is also more complicated than that. Initially, it seemed like a new standard that combined SATA physical interconnect with the modular bandwidth of PCI Express was the future for desktops and 2.5-inch drives. This is, or perhaps was, SATA Express.

COMPETING FOR LANES

In parallel, another new standard was born. It's known as M.2 and involves compact drives based on bare circuit boards, plugging directly into slots rather than via cables. M.2 is also based on PCI Express and looked ideal for both portable PCs and micro systems.

At the same time, a new control protocol optimized for solid-state storage—NVMe—popped up, and the future of PC storage seemed to make sense. And then it didn't. Firstly, while SATA Express was widely adopted by motherboard makers, actual drives failed to materialize.

The first USB Type C flash drives are just starting to appear on the market.

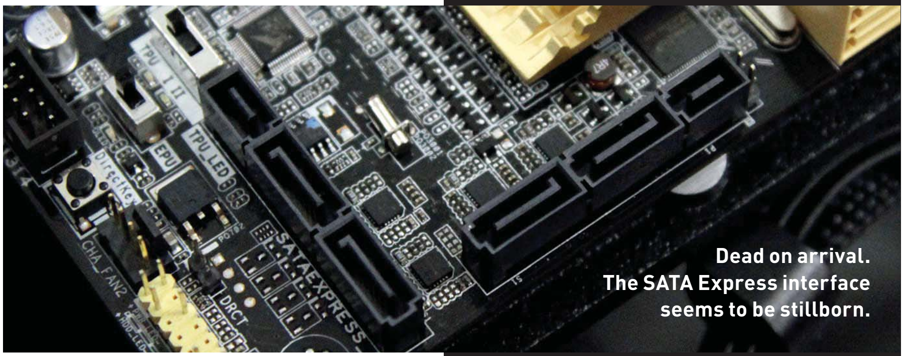
Meanwhile, although M.2 drives were launched and motherboards had slots to accept them, those drives lacked NVMe support, so the true promise of PCI Express storage wasn't realized. What's more, as we got to grips with the core concept of PCI Express storage, it became obvious that current Intel platforms aren't really built with it in mind.

That's because the native PCI Express connectivity is built into the CPU itself. For Core i5 and Core i7 CPUs on the LGA1150 socket, that connectivity is limited to a single port of single lanes. In an ideal world, all 16 of those lanes will be dedicated to graphics. Take just one away for use with an SSD, and the graphics subsystem will drop down to eight lanes.

Of course, what's left of the external chipset, the PCH, does provide another eight lanes. But these are slower 2.0-spec lanes rather than the CPU's 3.0 lanes. More to the point, the PCH connects to the CPU via a DMI 2.0 bus that shares its 20Gb/s across all subsystems. So, any PCI Express drives could be battling with the likes of USB devices for bandwidth.

In an ideal world, the CPU itself would have a few spare lanes to hook up to SSDs. That's exactly what will happen with Intel's next-gen Skylake CPUs. They get 20 native PCIe lanes, and so four to use for storage. The final part of the PCIe storage puzzle is U.2. For more on that, point your peepers at "U.2 comes to the PC," to the right.

Put all that together and the PCs of the future begin to take shape. Imagine, perhaps, a PC where all peripherals, including your ultra high-res monitor, are daisy-chained off a single port. Meanwhile, you'll have storage that cranks out the sort of GB/s speeds we used to associate with RAM. We may not be there yet, but at least you now know what's coming.



Dead on arrival. The SATA Express interface seems to be stillborn.

HIGH-BANDWIDTH INTERCONNECTS IN FULL

Interconnect	Usage	Physical Interface	Maximum Bandwidth
SATA	**Storage, 2.5-inch and 3.5-inch hard drives and SSDs**	**Cable**	**600MB/s**
SATA Express (probably dead)	**Storage, 2.5-inch SSDs**	**Cable**	**2GB/s**
U.2 (formerly SFF-8639)	**Storage, 2.5-inch SSDs**	**Cable**	**4GB/s**
M.2	**Storage, solid-state drive boards**	**Slot**	**4GB/s**
USB 3.1	**Almost anything bar 4K-plus displays**	**Existing Type A and B connectors**	**1.25GB/s**
USB Type C	**Almost anything bar 4K-plus displays**	**New compact, universal, and reversible connector**	**1.25GB/s**
Thunderbolt 3	**Almost anything including 4K-plus dislays**	**Physically compatible with USB Type C**	**5GB/s**

U.2 comes to the PC

NO, the rock band everyone loves to hate hasn't started shilling for Intel instead of Apple. Instead, if there is a musical connection, it's the artist formerly known as Prince. For U.2 is the storage interconnect formerly known as SFF-8639.

Yes, really. SFF-8639. We would ask who on Earth makes up this crap and expects consumers to have a clue what it means. But SFF-8639 was originally intended as an interconnect for enterprise-class systems, meaning that friendly branding that our pretty little heads can cope with understandably wasn't a top priority.

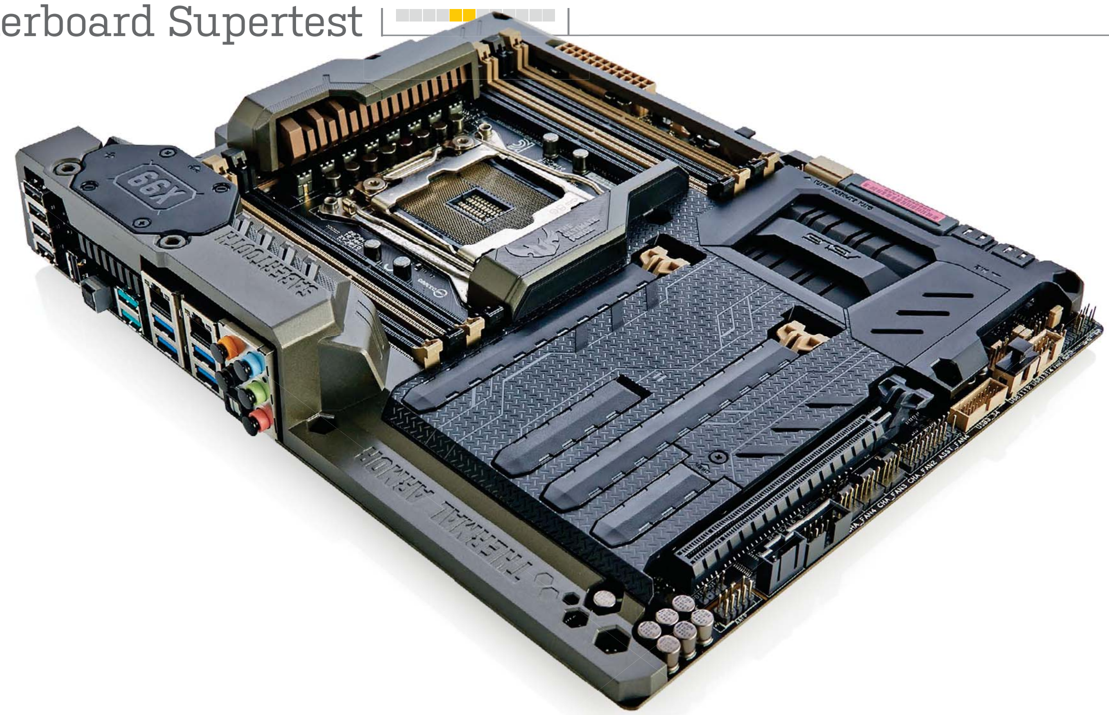
However, SATA Express hasn't taken off, and with SFF-8639 gaining some traction generally, Intel and the SSD Form Factor Working Group have decided to rebrand it as "U.2," to make it easier to grasp, and also to align it with the existing M.2 interconnect nomenclature.

U.2 resembles SATA Express in that it's a cable-connected interface similar to SATA, except it's using the PCI Express protocol. That means it's suitable for use with the 2.5-inch form factor SSDs that were the default option, until M.2 boards came along.

The difference is that U.2 supports up to four PCIe lanes, compared to SATA Express's two lanes. As a result, U.2 maxes out at 4GB/s, rather than 2GB/s.

Whether U.2 will truly take off, however, is unknown. One factor that may prevent wide adoption is, would you believe, cabling cost. Apparently, U.2 requires cabling with multiple individually shielded cables, driving up cable costs. Not attractive for motherboard makers operating under already monstrously tight margins.

Whatever happens, however, we just hope it happens soon. That way we can all relax a bit and get comfortable with our knowledge of what's coming with high-bandwidth interconnects.



ASUS SABERTOOTH X99

So sleek, so stealthy, so good

ASUS IS WELL KNOWN for its high-end componentry. Yes, it can come at a premium, but it's often money well spent if you're looking for feature-rich, reliable products. So, does this X99 board, in Asus's TUF series, hit that mark? Oh yes.

Since launch, the TUF brand has focused on two things: reliability and consistency. And, although the ROG and Workstation series still exhibit these traits, it's hard to argue with TUF's reputation for being the workhorse of the breed. Certainly, over the three years since its first Z77 chipset and its first thermally armored boards, these have been values that Asus has aggressively expanded upon.

This board looks spectacular, hiding the vast majority of the all-black PCB under the thermal armor, giving the Sabertooth an incredibly clean look. Whether or not you believe in the heat-regulating effects of TUF's layers of reinforced steel and plastic, it's hard to deny it looks stunning.

Internally, the board supports tri-SLI and Crossfire, thanks to three PCIe 3.0 lanes (for 16x16x8 or 16x8x4, depending on which monster you plug in to that 2011 socket). This gives you enough graphical horsepower to not bat an eyelid when staring down the barrel at our eternal enemy—frame rate. For storage, there's support for M.2 PCIe. Additionally, there's access to one SATA Express connection alongside eight standard SATA 6Gb/s ports. What's insane is the fact that Asus has managed to cram 11 fan headers across this board. But then that's something we've come to expect from Asus. With offerings such as Fan Xpert II and the TUF ICe chip solution (allowing for an additional five PWM controlled fans), the X99 outstrips almost all of the competition for cooling capacity.

For rear I/O, there's four USB 2.0 ports, four USB 3.0 ports, and two of ASMedia's new 3.1 ports, allowing for transfer rates of up to 10Gb/s. Unfortunately, there's no mention of USB 3.1 Type C, something that would've been nice on such a high-end board. Audio is handled with the standard 5.1 setup we've come to expect, with additional optical output, which is separated from the rest of the motherboard. It's supported by TUF's audio tinkering to make sure that there's as little electromagnetic interference as possible.

PLENTY OF BITE

Core features include Asus's current iteration of AI Suite and UEFI BIOS, all repackaged in TUF's military design, with easy automated overclocking features for the more faint-hearted.

As for performance, we overclocked our 5820K to a respectable 4.4GHz at 1.3v with relative ease, and achieved some strong benchmarks. The Sabertooth also comes with access to TUF Detective, a specialized USB port in the rear I/O, allowing you to hook up an Android device to monitor your mobo in real time, similar to the ROG Extreme Front Base, but with added utility and without being so cumbersome.

This Sabertooth is impressive. Its cooling potential is second to none, and certified with a five-year warranty, it certainly pulls its weight. Aesthetically, it's a beauty and we can't wait to get it into a proper build. We'll admit that it isn't cheap, but then if you're buying into the extreme edition processors, you're going to be used to paying that premium for reliability (and potentially looks, if you're into that kind of thing). If you're after a board that's a dab hand at gaming and overclocking, plus a dependable workstation, the Sabertooth is definitely worth your time.

VERDICT **9**

Asus Sabertooth X99

+ STALLION Feature-rich; thermal armor; sleek and sexy aesthetics; TUF Detective; huge cooling capacity.

− MULE Expensive; additional fan can be noisy; no USB 3.1 Type C.

$310, www.asus.com

SPECIFICATIONS

CPU Support	Intel X99 / 2011
Form Factor	ATX
USB 3.1 Support	2x USB 3.1 Type A
M.2 Support	M.2 PCIe SSD

ASROCK X99 E-ITX/AC

Impressive engineering that struggles to find a home

INSANITY, thy name is ASRock. We don't think there have been many companies out there who have thought to themselves: "You know what we need to do? A 2011 socket, ITX form-factor, go!"

The ASRock X99 E-ITX is nothing short of an engineering miracle—fitting an extreme edition processor into the ITX form factor represents a huge challenge. Considering the socket alone takes up 25 percent of the entire PCB, ASRock has been left with little-to-no room to maneuver. So, has it delivered on the promise of an insanity-packed Mini-ITX powerhouse? Sort of....

The board follows the traditional blue design SKU of the latest ASRock boards. Granted, you won't see much of it once you've slammed in a graphics card and two sticks of DDR4, but for what's it worth, it's not a bad-looking motherboard. At first. After you realize that you're left with that clumsy-looking small form factor custom CPU leaf blower, or a Cooler Master Seidon all-in-one, you might be feeling a little differently on the subject.

Internally, for storage, you have access to one Ultra M.2 PCIe, four SATA 6Gb/s ports, and a single SATA Express port, for the lucky few who have access to something that runs that. There is, of course, the standard USB 3.0 connector awkwardly positioned behind the PCIe slot. For cooling capacity, it's the usual slim pickings you tend to find with ITX (though more than with its Z97 little brother), with one CPU fan header and two chassis fan headers.

The rear I/O features four USB 3.0 ports, two USB 2.0 ports, an eSATA connector, the usual 5.1 audio connectors, plus TOSLink, PS2 Combo port, two Gigabit Ethernet connectors, and last, but certainly not least, the two USB 3.1 Type A connectors for up to 10Gb/s transfer speeds with the latest storage devices.

As far as performance goes, it's as solid as the rest of them. Something ASRock boards are well known for is their potential to overclock, and this board is no exception. We achieved a stable 4.4GHz on our Core i7-5820K, and, as you can see from the benchmarks on page 40, it pushed out some impressive numbers, even giving the Sabertooth a run for its money.

SO NOT COOL

Unfortunately, this board has one major setback, and that stems from the design of the socket itself. Although it's still reinforced with its own backplate, much like the other 2011 boards on the market, the mounting points don't correspond to the traditional 2011 form.

This means that you're incredibly limited as to what coolers you can effectively use. You're stuck with either ASRock's included CPU heatsink (that although effective, sounds like a small hurricane, even on silent mode) or a Cooler Master Seidon 120mm or 240mm all-in-one liquid cooler with the included bracket. It's less than appetizing for water-cooling enthusiasts and other PC builders.

There's no doubt the X99 E-ITX is an impressive piece of engineering from ASRock. If you're looking to set up an insane home server build with a 2011 chip at its heart, this could be a solid candidate.

Otherwise, however, the placement of this board in the market is confusing. It doesn't really have the memory capacity or storage connectivity needed for a professional-grade workstation, nor is it entirely comparable to what you'd expect from high-grade gaming motherboards. And let's face it, if you're buying a 2011 socket to game on, you'll probably be investing in more than one GPU anyway.

VERDICT
7

ASRock X99 E-ITX/ac

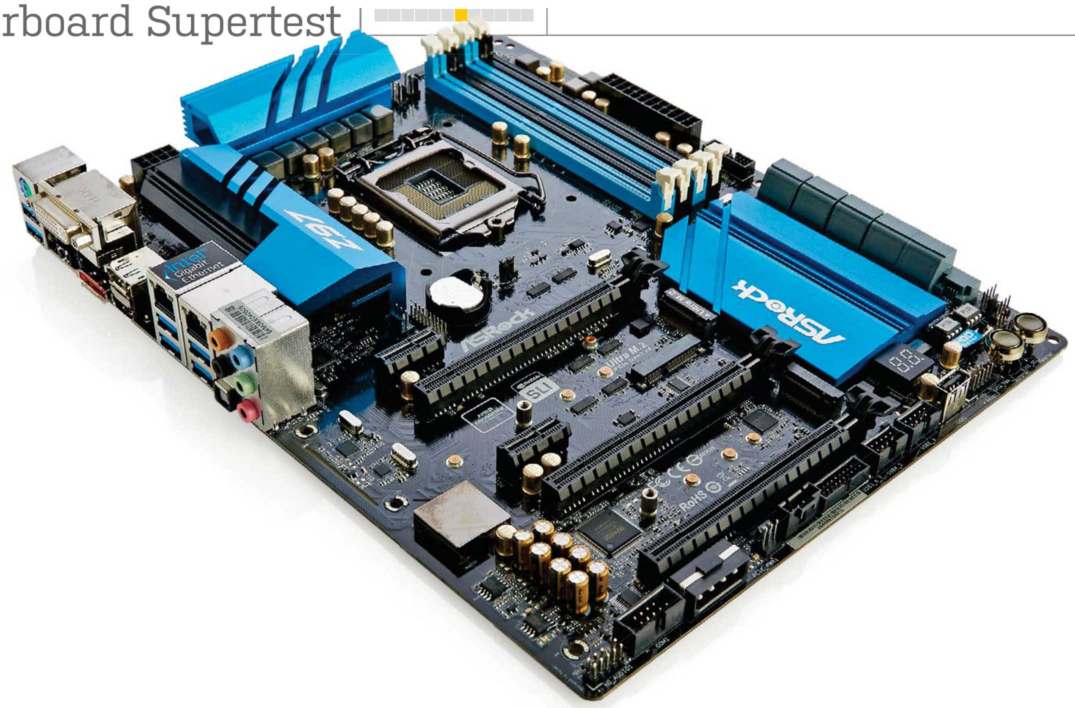
+ POWERHOUSE Small form factor; impressive design; strong integrated cooling.

− LEAKY ROOF Limited choice of coolers; no place in the market; not good looking.

$250, www.asrock.com

SPECIFICATIONS

CPU Support	Intel X99 / 2011
Form Factor	E-ITX
USB 3.1 Support	2x USB 3.1 Type A
M.2 Support	Ultra M.2 PCIe SSD



ASROCK Z97 EXTREME6

Storage support master defeated by overclocking

WE'VE HAD A BIT of a good run with ASRock in the Maximum PC Lab recently. Our "Overclocking Masterclass" (see page 42) is demonstrated using the Extreme4 edition motherboard, the little brother to this mobo here. We've also managed to achieve some insane overclocks on other ASRock boards, notably 5GHz on its Z77 ITX motherboard, with a tiny little Corsair Hydro H60. As a result, we're expecting big things from this one. Anyway, we digress. This board is the Extreme6, the more feature-rich edition of ASRock's professional line.

ASRock has gone with a blue design style with the latest Z97 and X99 chipset that we all love here. It's nice to see someone else take it on after MSI and Asus seemingly dropped it in the dust following the release of Sandy Bridge. However, unlike the X99 ITX board we reviewed on page 31, you can actually see this board when you place a few items inside the thing.

Internally, this board blows away the competition for storage support. It comes with both an Ultra M.2 Socket, for transfer speeds of up to 32Gb/s, and a standard M.2 socket maxing out at 10Gb/s. There's a further eight SATA 6Gb/s ports and one SATA Express port. For cooling, the pickings aren't as generous. There's access to six on-board fan headers (including the CPU fan), but then ideally you shouldn't be using all of them anyway. We prefer using fan controllers to save on cable mess mostly. For GPU support, you're looking at Quad Crossfire and SLI with three PCIe Gen3 slots. Not that we can imagine many will be running four graphics processors, but the option is there if you need it.

This board is rammed with additional features, a prime example of why motherboard prices continue to go upward. HDD save connectors, Thunderbolt AIC connector, BIOS, internal power, and reset switches are just a few of the features that helped make the testing for this Z97 go a lot smoother than with many of the others.

Fortunately, due to the premium nature of this ASRock, you're really spoiled for choice when it comes to I/O, with two Gigabit Ethernet connectors, DVI-I, DisplayPort, HDMI, six USB 3.0, a PS/2 port, and the usual 5.1 audio and optical output. The only downside to this particular motherboard is that USB 3.1 is accessed via a PCI add-on card, though it does feature both 3.1 Type A and Type C, meaning you'll be more than future-proofed.

OVERCLOCKING FAIL

Now for the bad news. Unlike almost all the other motherboards in this supertest, the Extreme6 failed to achieve the 4.8GHz on our Core i7-4790K. No matter what we did, we just couldn't reach our standard overclock for the Core i7. This really is a shame considering how well ASRock's motherboards have overclocked in the past. At maximum, we managed an overclock of 4.6GHz, which still produced some good benchmarks, but nowhere near the others in this category.

Despite that, the Extreme6 is a very tempting purchase for the price, no doubt. With features and connectivity that you'd be expected to pay a fair bit more for from other manufacturers, we'd be hard-pushed to suggest any other board for those wanting to get into the USB 3.1 market.

For professionals who aren't prepared to buy into the 2011 socket just yet, there's certainly no question. It has an incredible range of storage support and expandability, it's a stable choice, and, even though it may lack the overclocking potential of some of the other boards, it's still a good buy.

VERDICT 7

ASRock Z97 Extreme6

+ PROFESSIONAL Storage capacity; looks great; fan support; good value.

− RANK AMATEUR Doesn't overclock well; BIOS problematic; USB 3.1 add-on card.

$150, www.asrock.com

SPECIFICATIONS

CPU Support	Intel Z97 / 1150
Form Factor	ATX
USB 3.1 Support	1x USB 3.1 Type C 1x USB 3.1 Type A
M.2 Support	1x M.2 1x M.2 SSD 1x M.2 Ultra

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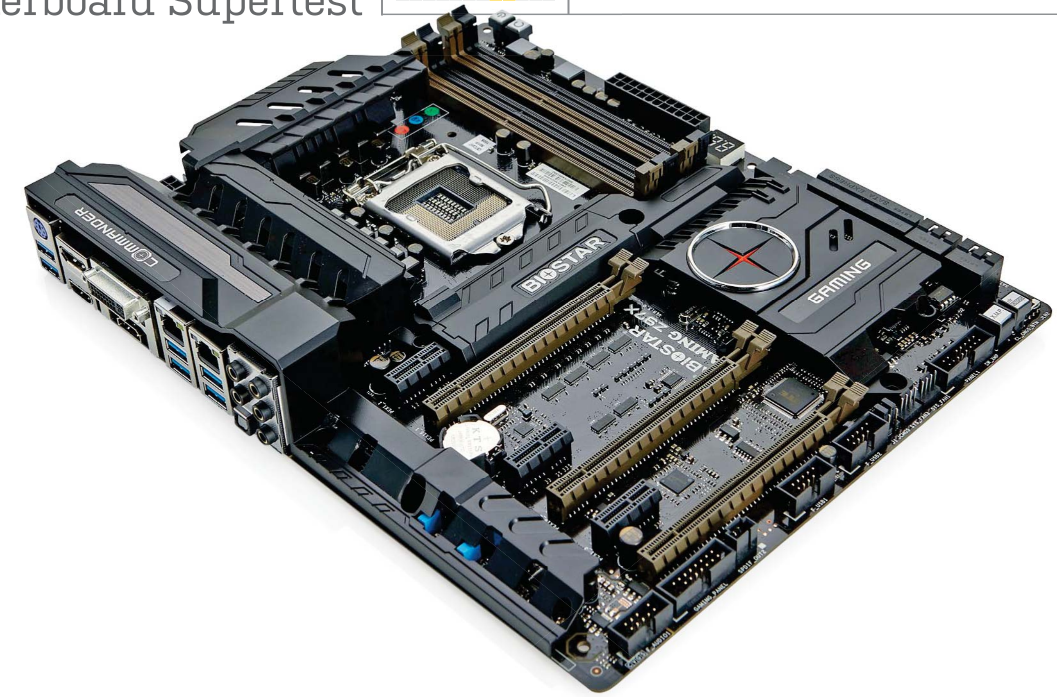


BIOSTAR Z97W GAMING

Welcome to the year 2005

WHAT CAN WE SAY about Biostar? As a company, some of us weren't even aware it existed until a month ago. That was until it debuted a new range of rather interesting consumer Z170 boards at Computex, boards with a strange ability to swap between using two sticks of DDR3 or two sticks of DDR4, depending on your budget. The Taiwanese manufacturer, of course, has actually been around for decades, but has traditionally leaned more toward business-to-business sales, as opposed to the enthusiast end of the market. So, what can be said for its Z97 gaming motherboard?

It's certainly a blast from the past. The general look and layout of the board is very reminiscent of the Sabertooth, but only to a small degree. The plastic covers feel anything but premium, and we're definitely concerned about how this particular type of plastic will cope with high temperatures on the northbridge and southbridge.

The biggest problem we had with this board, by a country mile, was the plastic shroud covering the audio componentry and the rear I/O. To put it simply, our test bench consists of a reference GeForce GTX 980, and it simply would not fit. No matter what we tried, and however much force we used (and it was as painful as it sounds), we simply couldn't get the GPU to make contact with all of the PCIe slot due to the plastic shroud coming into contact with the bottom of the card. That was that.

So OK, the board could stand to look a little better, and the design of the shroud could have been better handled, but what about the inner workings? GPU support is done through two PCIe 16 slots (for x8x8), and there's Crossfire support, but no way of running SLI. There's also an additional two USB 2.0 headers, six SATA 6Gb/s ports, one SATA Express port, one M.2 SATA connector, and a grand total of five fan headers. There are some more useful features, including a right-angled USB 3.0 header and on-board XMP/Start/Reset buttons. An odder inclusion is an LN2 switch—we can't imagine who would want to use this board to try and break world-record overclocks, but still, if you want it, the feature is there.

BAD, BAD BIOS

Rear I/O consists of a PS/2 port, four USB 3.0 ports, and two Gigabit Ethernet connectors (one provided by Killer, the other Intel). There's also VGA, DVI, Displayport, and HDMI connectors, plus six-channel audio (but no optical output). It's an odd concoction and, granted, there isn't a wide variety of optical supporting speakers out there, but it's a good bonus to utilize them if you have a set.

For performance, the board was pretty mediocre. It failed to achieve our 4.8GHz overclock on our Core i7-4790K, and didn't blow us away with numbers either. The plastic shrouds (which, on further inspection, covered the metallic heatsinks) also got quite toasty. The BIOS is less than desirable— it's about as intuitive as a kick in the face and is possibly the worst-looking one we've seen. Overall then, not exactly impressive for a $200 board.

Ultimately, we can't recommend this mobo to anyone. It's not a good-looking component, and the potential drawbacks for those trying to plug in any reference card or GPU that you're not entirely sure about is far from fantastic. Yes, it performs well, but it lacks a lot of the features you'd expect at this price. If you are, however, missing 2005 and fancy a very ugly front bay device as well as a motherboard to match, this may be the product for you.

VERDICT
4

Biostar Z97W Gaming

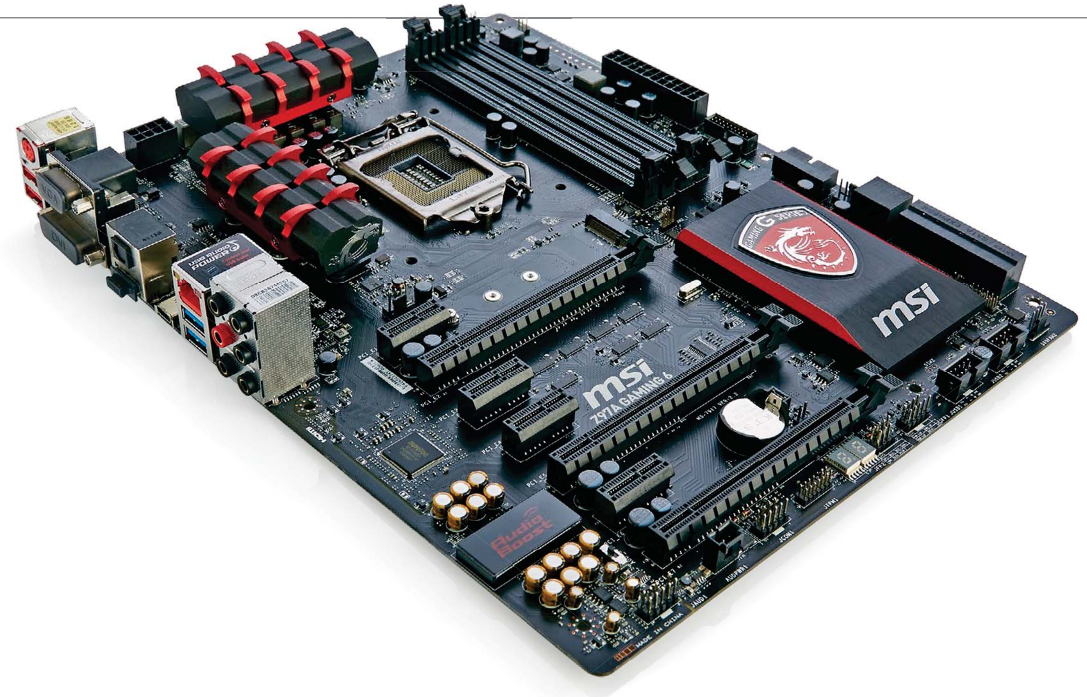
+ BIOSTAR It is technically a motherboard; onboard power switches; right-angled USB 3; USB 3.1 ports.

– BIOHAZARD Rear I/O Shroud; poor overclocker; ugly BIOS; feels cheap; not easily accessible; pricey.

$201, www.biostar.com.tw

SPECIFICATIONS

CPU Support	Intel Z97 / 1150
Form Factor	ATX
USB 3.1 Support	2x USB 3.1 Type A
M.2 Support	1x M.2 connector



MSI Z97 GAMING 6

Great entry-level gaming motherboard

MSI GAMING, albeit a new line in MSI's arsenal of products, has had a tangible effect on the marketplace. And you can tell. With so many manufacturers creating their own "gaming" series in response to MSI's fiery dragon, it has quite the reputation to live up to. So, is MSI's Z97 Gaming 6 motherboard worthy of wearing the prestigious red garb displayed by so many of its brothers?

Well, for starters, it's worth noting that this board wears a cheaper price tag than some of the mobos in this supertest, even for this socket. As such, it's understandable that it's not overflowing with quite so many flair touches as some of its competitors.

This means smaller heatsinks, less glamorous cooling solutions, and generally not a lot of color beyond that. Despite that, however, it still features a fully black PCB, black and red Northbridge heatsinks and a rather nice illuminated line that separates the audio solution from the rest of the PCB, just in case we didn't know that it wasn't separated already. But, we have to admit, we like its implementation.

Let's face it, however, this is only half of the story. What about the guts? Well, the Gaming 6 comes with an internal M.2 slot for 10Gb/s drive speed, one SATA Express port, and an additional six SATA 6Gb/s ports. This means your storage troubles are entirely covered, regardless of what you decide to do.

There's also access to two sets of internal USB 3 headers, one of which is (excellently, we might add) right-angled to allow for easier cable routing and management of that tricky front I/O cable we've all come to hate. And, of course, there's the plethora of fan connectors and additional USB 2 ports. Handy if you're plugging in an all-in-one water cooler, such as the Corsair Hydro series or NZXT's Kraken.

For PCIe support, MSI has kindly provided three PCIe Gen3 slots for use in 16x0x0, 8x8x0 or 8x4x4, so ideally, you don't want to be pushing more than two-way Crossfire or SLI.

BASIC, BUT SOLID

Rear I/O is a little slim on the ground here, but for the price point, that's to be expected. There's access to two USB 3.0 ports, two USB 2.0 ports, a single Gigabit Ethernet, VGA (God forbid you're still using a VGA monitor), DVI-I, HDMI, Optical Audio out, 5.1 audio, a PS/2 port for backward compatible/lag free gaming, and one single USB 3.1 Type C port. It's important to note here that there's only one USB 3.1 port on this motherboard and it's the Type C standard, so it won't work with more traditional USB devices.

The Z97 Gaming 6 is certainly a solid performer when it comes to overclocking, as well as general all-round performance. Although it does take some time to get your head around the UEFI BIOS, we did then manage to overclock the old girl up to a very respectable 4.8GHz, in line with the rest of our motherboard benchmarks, while still managing to maintain our memory frequencies at 2,133MHz.

All in all, this motherboard is a fantastic entry-level board to the world of PC gaming. It doesn't come absolutely ram-packed with features and as large a software set as some of the other products in this supertest, but it's got more than enough for the average gamer.

So, if gaming is your M.O., and you love a bit of the old black and red color scheme, this mobo is definitely a solid choice. If you have a bit of extra cash in your pocket though, we'd suggest getting the Z97A Gaming 7 or 9 instead, as you'll be much better off in the long run with regards to USB support and general expandability.

VERDICT
8

MSI Z97 Gaming 6

+ BLOOD RED Great value; performs well; looks great; USB 3.1 Type C; right-angled USB 3.1.

− OFF PINK Lacks features; cooling support is limited; difficult install.

$160, www.msi.com

SPECIFICATIONS

CPU Support	Intel X99 / 1150
Form Factor	ATX
USB 3.1 Support	1x USB 3.1 Type C
M.2 Support	1x M.2

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MSI 970A SLI KRAIT EDITION

Beginner board hampered by aging chip

ONE SIMPLE QUESTION always hounds those who are about to embark on the creation of a new PC: Do you go Intel or do you go AMD? Usually, those who are new to the world of PC gaming tend to opt for Intel. That's at least partly down to how easy it is to identify what is new and what isn't with Intel, a route that AMD hasn't chosen to follow. Each time AMD releases a new CPU, instead of forcing a new chipset, it makes sure it's backward compatible so its customers don't have to change out their motherboards. Decidedly then, this can make it quite challenging to find out which AMD boards are new and which are old.

And so to the matter at hand. MSI has brought to the table this visually arresting M3+ 970 board. Featuring a unique black and white color scheme, we already have a plethora of build log ideas for how to best take advantage of the looks of this 970A. It's certainly nice to see MSI pushing out new motherboards for AMD sockets, especially ones that look as good as this. It would also go quite nicely with MSI's Krait Edition GPU line as well.

Because of the low price point though, the Krait suffers from a lack of options in regard to internal expandability, supporting only two-way graphics fun, through PCIe Gen2. This is mostly down to the limitations of the AM3+ platform and a CPU dating all the way back to 2011.

Storage is taken care of by six SATA 6Gb/s ports, and that's about it. There are three fan headers, including the CPU socket, but besides the usual mix of USB 2.0 ports and two front USB 3.0 ports, that's all she wrote. If you're looking to put together a water-cooled build, or are including this mobo in an airflow-optimized case, you may want to invest in a fan controller to help solve this situation.

OLD ONES AREN'T THE BEST

External I/O is a slightly better story, where the interesting magic happens with the new USB standard. MSI has provided two USB 3.1 Type A ports, which allow for transfer speeds of up to 10Gb/s, though this is only supported by MSI's proprietary drivers. On top of this, there's an additional six USB 2.0 ports, one Gigabit Ethernet, two PS/2 ports, and then the standard audio connectors, but no optical output for those that utilize high-end audio.

Performance is intriguing on this Krait. The 970 chipset isn't one that's generally designed around overclocking. However, MSI has included a nicely skinned UEFI BIOS to help those who are interested in doing a little bit of overclocking on the board. Otherwise, you're a little limited. But again, this is primarily down to the AMD CPU already being four years old at this point and not supporting features such as PCIe Gen3, or even memory frequencies above 2,133MHz.

The major problem we found, however, when even attempting to overclock AMD's CPUs, was the heat output. It simply wasn't particularly easy for us to achieve a sustainable overclock that we felt comfortable with on a single radiator AIO water cooler.

But then you have to remember that this board comes into the market at around $90. In this regard, it's a fantastic entry-level gaming motherboard for those looking to get into the PC gaming scene. It comes with expandability to support two-way Crossfire or SLI, and generally will keep you running with some basic expandability for future upgrades. But if you're looking for a competitive, feature-rich board, this isn't the one for you.

VERDICT 6

MSI 960 SLI Krait Edition

+ LIGHTNING STRIKER Great color scheme; USB 3.1 support; software skins.

− MARSHMALLOW No M.2 support; limited SATA support; rear I/O is lacking; AMD CPU is aging.

$90, www.msi.com

SPECIFICATIONS

CPU Support	AMD 970 / AM3+
Form Factor	ATX
USB 3.1 Support	2x USB 3.1
M.2 Support	N/A

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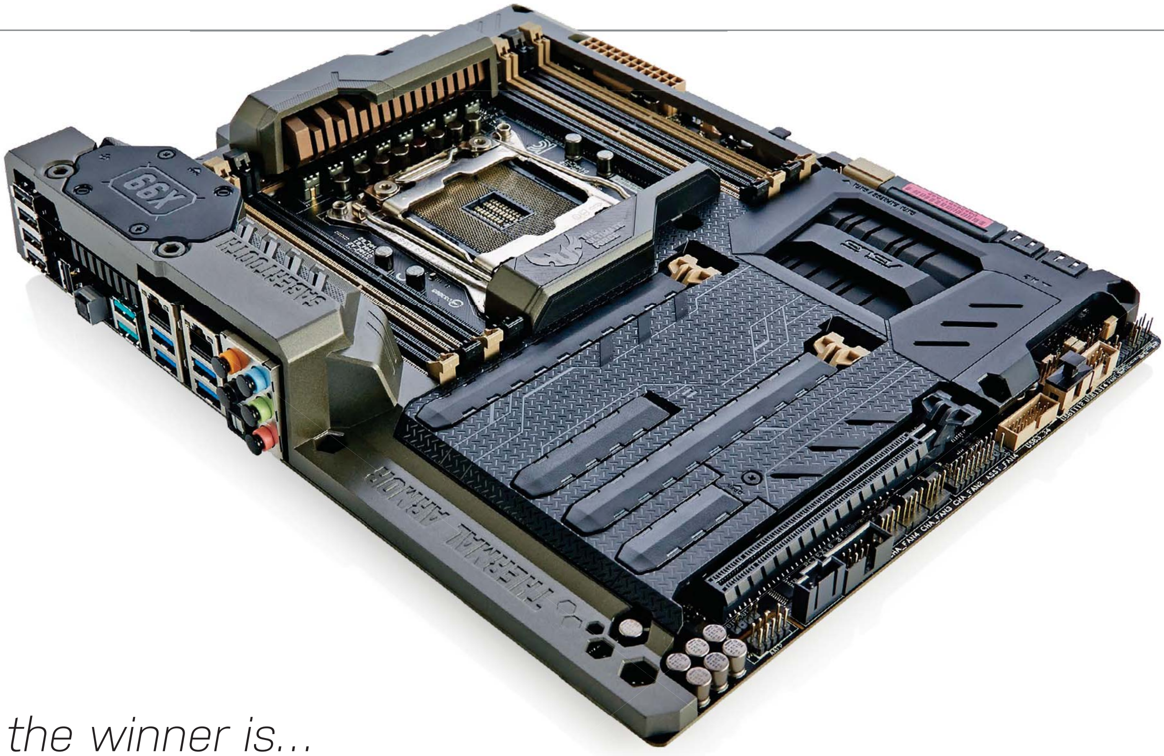
BENCHMARKS

	Asus Sabertooth X99	ASRock X99 E-ITX/ac	ASRock Z97 Extreme6	Biostar Z97W Gaming	MSI Z97A Gaming 6	MSI 970 SLI Krait Edition
Cinebench R15 (index)	1,016	995	839	844	873	507
x264 (fps)	22	22	18	19	19	12
SiSoft San Memory Bandwidth (GB/s)	39	25	17	19	20	22
AS SSD Sequential Read (MB/s)	495	495	359	484	488	479
AS SSD Sequential Write (MB/s)	346	351	333	342	344	337
PC Mark (index)	4,082	4,029	4,239	4,236	4,216	3,046
OC Cinebench R15 (index)	1,267	1,253	917	925	965	N/A
OC PC Mark (index)	4,236	4,484	4,421	4,014	4,520	N/A

Overall winner is highlighted. All tests were run on the same hardware, using a GeForce GTX 980, 8GB of DDR3 2,133MHz RAM, Corsair Neutron SSD, and NZXT Kraken X61 CPU cooler. The X99s were tested with an Intel Core i7-5820K and 16GB of 2,133MHz DDR4; Z97s with a Core i7-4790K; and the AMD 970 tested with an FX-8320E.

SPECIFICATIONS

	Asus Sabertooth X99	ASRock X99 E-ITX/ac	ASRock Z97 Extreme6	Biostar Z97W Gaming	MSI Z97A Gaming 6	MSI 970 SLI Krait Edition
Chipset	Intel X99	Intel X99	Intel Z97	Intel Z97	Intel Z97	AMD 970
CPU Support	2011	2011	1150	1150	1150	AM3+
Form Factor	ATX	E-ITX	ATX	ATX	ATX	ATX
USB 3.1 Support	2x USB 3.1 Type A	2x USB 3.1 Type A	1x USB 3.1 Type C 1x USB 3.1 Type A	2x USB 3.1 Type A	1x USB 3.1 Type C	2x USB 3.1
M.2 Support	M.2 PCIe SSD	Ultra M.2 PCIe SSD	1x M.2; 1x M.2 SSD; 1x M.2 Ultra	1x M.2 connector	1x M.2	N/A
Website	www.asus.com	www.asrock.com	www.asrock.com	www.biostar.com.tw	www.msi.com	www.msi.com
Price	$310	$250	$152	$201	$160	$90
Score	9	7	7	4	8	6



And the winner is…

ASUS SABERTOOTH X99

THERE'S NO SHADOW of a doubt that if you're looking for a motherboard that hits all the marks, Asus's Sabertooth X99 is a solid board. Not only is it a mean-looking workaholic, it's also packed with more features and cooling support than you could shake a braided cable at. Asus's TUF ICe fortifier is a great piece of componentry in itself, improving cooling performance and fan curves to a degree that's comparable to most aftermarket fan controllers. Granted, it's quite the pricey mobo, but the fact Asus has managed to get so much onto a single motherboard, and still keep it looking so clean, is not something to be shunned.

ACROSS THE BOARD

The ASRock X99 ITX is a remarkable feat of engineering by the Taiwanese company. Unfortunately, so much of what makes the extreme edition processors so enticing and powerful has been given up for the sake of hitting that tiny form factor. Two DIMMs, three fan controllers, and a lack of support for serious storage lead to this mobo's downfall. Even with ASRock doing its best, the solutions just aren't competitive with other motherboards of its class. It simply doesn't make sense in the marketplace. It's not a gaming motherboard, it's not a workstation-class board, it's not even a server-grade board. What is it?

That said, its other USB 3.1 offering here, the ASRock Z97 Extreme6, provided us with another innovative solution to the USB 3.1 dilemma—maybe it's possible to overcome these problems by just including a PCI USB 3.1 add-on card. Although not the most gracious of all the implementations we've seen here, it's certainly the most expansive, including both USB 3.1 Type A and Type C connectors, something none of the other boards featured. Unfortunately, even disregarding the somewhat flaky implementation of the USB 3.1 add-on card, the Z97 Extreme6 just couldn't produce the goods when it came to overclocking. If it can't even handle our stable overclock, we're concerned about what sort of general longevity this board will be able to achieve.

An alternative to the Extreme6 is MSI's Z97 Gaming 6, and although it came in at a moderately attractive price point for an Intel motherboard, it felt a little lackluster for looks and features. Something not mentioned in the review was the difficulty we had getting anything to work without drivers, including the Gigabit Ethernet, among other things. But generally, the board just couldn't cut it in comparison with the Sabertooth. More so than the ASRock Z97, but still. It remains a great entry-level board to get yourself into the Intel PC gaming scene, but worth an upgrade for its USB 3.1 features alone? Sadly not.

Next, we get to MSI's 970 Krait SLI Edition, a board that looks stunning, but is mostly held back by the socket it supports. Really, there's not a lot we can say. If you're interested in upgrading within the AMD FX platform, then sure, this is definitely the board you want—it looks good, and caps out on all of the features you can get on AMD's painfully aging four-year-old CPUs. But AMD's platforms just feel too dated.

BEST AND WORST

When it comes to the Biostar, where do we start? It didn't hold up whatsoever, not to our overclocks, not to build quality, and definitely not to price for performance.

All of which means the Asus Sabertooth X99 remains the best motherboard that you can upgrade to if you're on the 2011 platform already, or are considering making the move up to the extreme edition processors. You're truly spoiled with the features that this board provides. Yes, $310 is a chunk of cash for a motherboard, but it's well worth it.

> **“Not only is it a mean-looking workaholic, it also comes packed with more features than you could shake a braided cable at.**

FREE SPEED!

OVERCLOCKING MASTERCLASS

The hardware, software, and know-how you need to get the most from your PC

By Zak Storey

Overclocking. It's long been a part of a PC enthusiast's toolkit when it comes to wringing every last ounce of power from our beloved machines. Whether you've opted to run AMD or Intel, overclocking has been a staple food group of the techie's diet for as long as there have been chips in PCs. The basic principle is very simple: Add more voltage to the component part, provide it with sufficient cooling, either through water or air (or Ln2 for the more adventurous among us), and increase the Hz output of the hardware you're trying to improve.

But this doesn't come without risk. While we've come a long way in the world of overclocking, it is still possible to fry your CPU, GPU, RAM, or motherboard to the point where it's more charred than your old man's best barbecued sausages. So, the first question you should always be asking yourself is whether it's worth the risk. The answer, generally (and, ahem, unhelpfully), is sort of.

As proven time and again by Intel's latest and greatest chips, a good-quality CPU core often outstrips an increase in gigahertz. On the flip side, however, increasing the performance of a two-year-old core so that it can keep pace with the newer generation can save you a pretty penny, and possibly put off that upgrade for another year or more. So read on for step-by-step guides to overclocking your CPU, RAM, and GPU.

Overclocking Your CPU

Learn to fulfill your processor's potential in 10 simple steps

Before crossing the start line, there are a few basic principles to get your head around. The first one is heat. Inevitably, the more voltage you add to your components, the more heat that component is going to output. Second, the higher the clock speed you're trying to achieve, the more voltage you will need to power that attempt. And third, there's only so much voltage your PC part can take before you start to see detrimental effects. These could be a drop in frame rates for GPUs, corrupting processes on the CPU, or even a failure to boot at all. These, essentially, are the basic limits of overclocking.

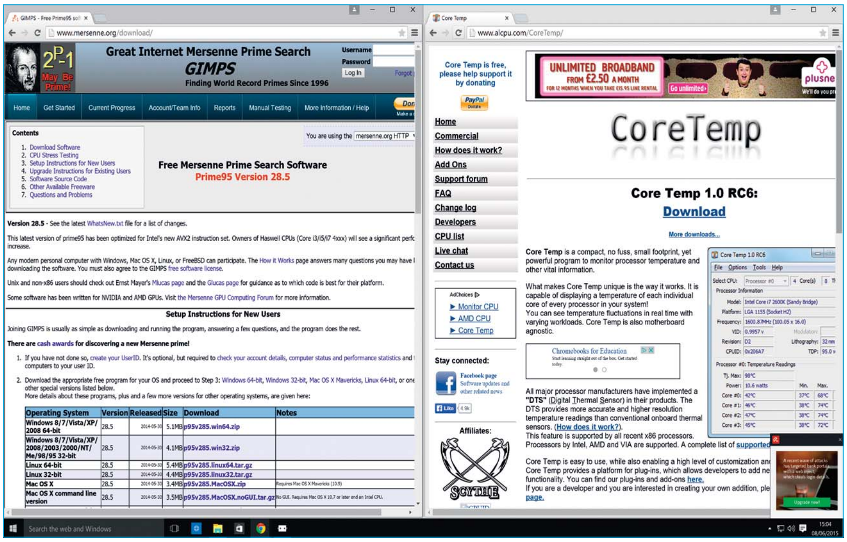
All chips are born equal, but some are more equal than others. You'll often hear overclockers talk of "The Silicon Lottery." In short, this is to do with the manufacturing process with each and every processor. Small imperfections in the application of the silicon lead to a variance in how well the chips perform, both in stability with an increase in voltage, and how much heat they produce at max load. You might get lucky with yours, or you might not. It can equate from anywhere between 0.2GHz difference to, in some cases, up to 1GHz in overclocking potential.

So, assuming you've got an aftermarket cooler of some description (see "Picking a Cooler," on page 46), that you have a processor or component that's capable of overclocking (K/X series for Intel and any AMD chip), and that you understand how to get into your BIOS, here's how to get going.

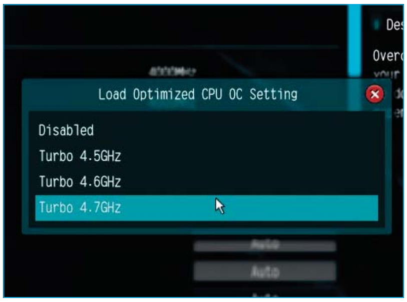
1 CHECKING CPU STABILITY

To ensure a successful overclock, we'll need to know that the CPU is stable at both idle and max load. To do this, we'll be using a free piece of software that's called Prime95, from http://bit.ly/1kVNJZh.

You'll also want to download a program to accurately monitor the temperatures your CPU is outputting. For this, we'll use Core Temp, from www.alcpu.com/CoreTemp/, as this works with both AMD and Intel cores. There are alternatives out there—Corsair and NZXT have proprietary software that works with their AIOs, plus most motherboards have viewable temperature controls that you can use from the desktop. If you don't want to install anything on your rig, then Real Temp GT is your guy.


GIMPS - Free Prime95 software
Great Internet Mersenne Prime Search
GIMPS
Finding World Record Primes Since 1996
Free Mersenne Prime Search Software
Prime95 Version 28.5
Core Temp
CoreTemp
Core Temp 1.0 RC6:
Download
UNLIMITED BROADBAND FROM £2.50 A MONTH

Prime95 is a key overclocking tool, with its stress tests being a major part of the process.



Default profiles limit potential, but are often safer than manually entering them.

2 CORE TEMP

Once those programs are extracted or installed, load Core Temp to begin monitoring your CPU's temperature. Always look at the lowest core temperature to give yourself a good understanding of how hot your CPU is running.

3 STRESS TESTS

Now we'll want to benchmark your CPU, at stock, to see how hot it runs at 100 percent. Start Prime95, select "Just stress testing," and then you'll be given a list of options as to which stress test you'd like to perform. Choose "Blend Test" and press "OK."

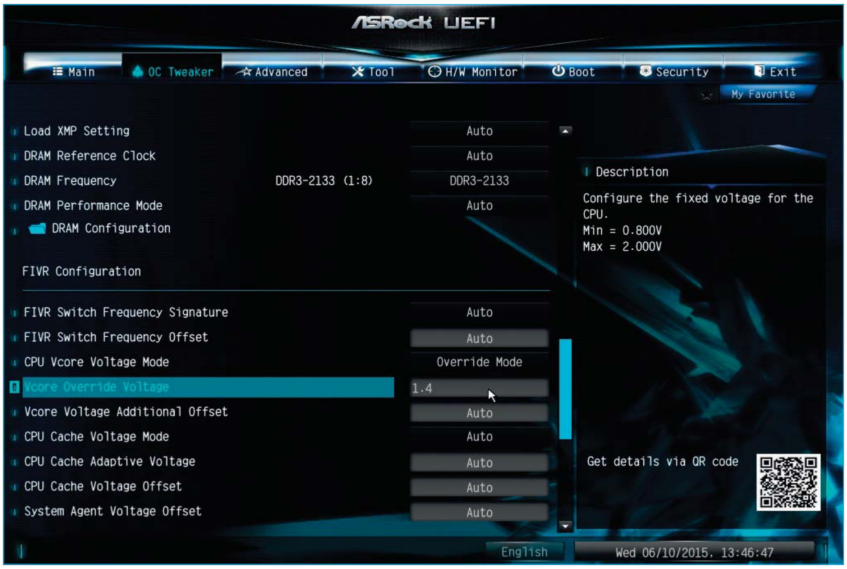
4 INTO THE BIOS

After about 5–10 minutes, once your temperatures have stabilized, go into Prime95. Select "Test" on the top bar and hit "Stop," then restart your PC and mash that Delete key to get into your BIOS. In this test, we're using an ASRock Z97 Extreme 4 motherboard, so the UEFI could be a little different in comparison to some of the other manufacturers you'll find out there, but the base settings will essentially be the same.

5 AUTO-OVERCLOCK

Once inside your BIOS, find the overclocking tab. In ours, it's named "OC Tweaker." Once in, you have several options. The easiest way to overclock your CPU is to let the motherboard do the majority of the work. Most manufacturers will include overclock profiles, usually ranging from 4GHz to 4.8GHz, depending on the CPU installed.

Setting the motherboard to run one of these profiles will allow it to attempt to overclock the chip to that frequency without any user input. This can be a quick solution, especially if you're only dialing in



Load XMP Setting: Auto
DRAM Reference Clock: Auto
DRAM Frequency: DDR3-2133 (1:8) DDR3-2133
DRAM Performance Mode: Auto
DRAM Configuration

FIVR Configuration

FIVR Switch Frequency Signature: Auto
FIVR Switch Frequency Offset: Auto
CPU Vcore Voltage Mode: Override Mode
Vcore Override Voltage: 1.4
Vcore Voltage Additional Offset: Auto
CPU Cache Voltage Mode: Auto
CPU Cache Adaptive Voltage: Auto
CPU Cache Voltage Offset: Auto
System Agent Voltage Offset: Auto

Description
Configure the fixed voltage for the CPU.
Min = 0.800V
Max = 2.000V

Get details via QR code

English
Wed 06/10/2015, 13:46:47

This looks like it'll be stable.

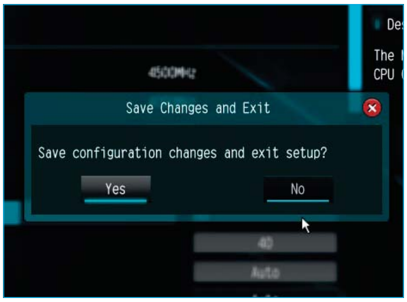
a conservative overclock (3.5GHz to 4GHz, for example), but this isn't conducive if you want to push beyond that 4.8GHz barrier, or if you can't reach that frequency through the automated profiles.

6 CHANGING THE MULTIPLIER

More adept users will find manual control a lot more comprehensive in regard to what true overclocking is all about. To keep it simple, you want to be changing the CPU ratio, or multiplier, for all cores to the target number you wish to achieve. That's 35 in this case. The multiplier then works with the cores' BCLK frequency (usually 100) to create that final figure of 3.5GHz. In this tutorial, we're going to attempt to overclock our CPU, just to start with, from 3.5GHz to 4GHz, simply by changing the multiplier.

7 TEST AT MAXIMUM LOAD

Once you've changed the CPU ratio multiplier to 40, save changes and exit the BIOS. Boot into Windows, open Core Temp to monitor your CPU temperature, then open Prime95 and select "Options," "Torture Test," then "Blends Test," to see how your chip fairs at maximum load. If it's stable for at least five minutes, we can then begin to up the multiplier to try to achieve a higher overclock.



Save Changes and Exit

Save configuration changes and exit setup?

Yes No

This process can be a bit repetitve, but it's definitely worth it.

8 FINDING THE LIMIT

At this point, you'll want to increase the multiplier by one and repeat the process of stress testing in Windows each time, until you reach the point where you initially either blue screen or your CPU begins to thermally throttle itself. Ideally, you want to blue screen before you reach your thermal limit.

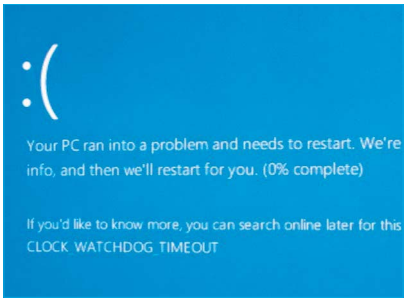
9 INCREASING THE VOLTAGE

To overcome the blue screen issue, we need to start working with the Vcore voltage. Back in the BIOS, you want to find CPU Vcore Voltage Mode. Change this to "Fixed." At this point, you may need to do some research as to what stock Vcore level your CPU takes, and what people are suggesting for overclocking. You'll want to begin increasing the voltage by 0.01 volts each time, until you can successfully boot, stress test, and maintain stability at your target frequency. Once you get a little more comfortable overclocking, you'll find yourself increasing voltages by 0.05 or 0.1 at a time. It's more about learning how your CPU responds to different amounts of voltage at this point.

Eventually, you'll reach a point where you cannot reach that next frequency, regardless of how much voltage you throw at it. This is when you want to dial back your overclock by 0.1GHz and drop the Vcore voltage back to the last stable settings for that frequency and maintain it there, as this is your final overclock.

10 BACK TO BENCHMARKING

To ensure a stable overclock, you should now benchmark using Prime95 and CoreTemp for as long as you feel is appropriate. This can be anywhere from an hour to a full day, depending on how patient you are.

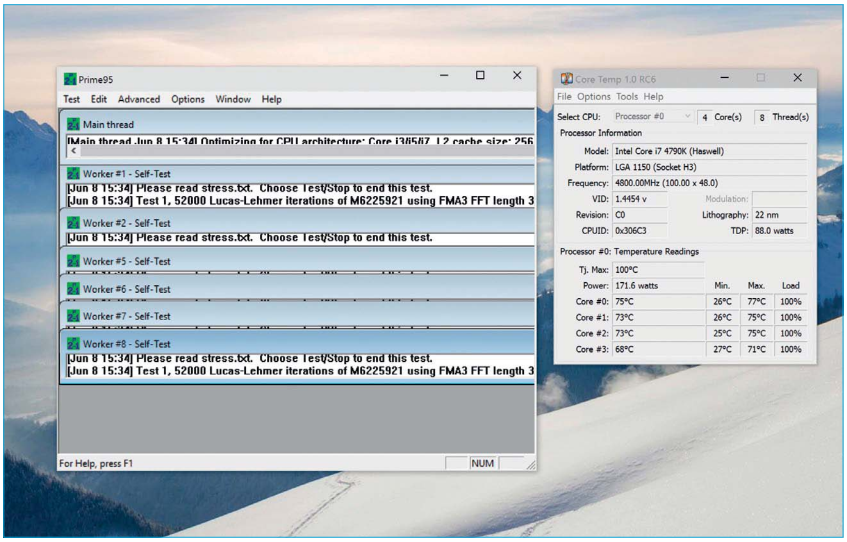


:(

Your PC ran into a problem and needs to restart. We're
info, and then we'll restart for you. (0% complete)

If you'd like to know more, you can search online later for this
CLOCK_WATCHDOG_TIMEOUT

Welcome to the blue screen of death.
It's time to start playing with the voltage.



Main thread

```
[Main thread Jun 8 15:34] Optimizing for CPU architecture: Core i3/i5/i7, L2 cache size: 256
```

Worker #1 - Self-Test

```
[Jun 8 15:34] Please read stress.txt.  Choose Test/Stop to end this test.
[Jun 8 15:34] Test 1, 52000 Lucas-Lehmer iterations of M6225921 using FMA3 FFT length 3
```

Worker #2 - Self-Test

```
[Jun 8 15:34] Please read stress.txt.  Choose Test/Stop to end this test.
```

Worker #5 - Self-Test

Worker #6 - Self-Test

Worker #7 - Self-Test

Worker #8 - Self-Test

```
[Jun 8 15:34] Please read stress.txt.  Choose Test/Stop to end this test.
[Jun 8 15:34] Test 1, 52000 Lucas-Lehmer iterations of M6225921 using FMA3 FFT length 3
```

Select CPU: Processor #0 4 Core(s) 8 Thread(s)

Processor Information
Model: Intel Core i7 4790K (Haswell)
Platform: LGA 1150 (Socket H3)
Frequency: 4800.00MHz (100.00 x 48.0)
VID: 1.4454 v
Modulation:
Revision: C0
Lithography: 22 nm
CPUID: 0x306C3
TDP: 88.0 watts

Processor #0: Temperature Readings
Tj. Max: 100°C

Power:	171.6 watts	Min.	Max.	Load
Core #0:	75°C	26°C	77°C	100%
Core #1:	73°C	26°C	75°C	100%
Core #2:	73°C	25°C	75°C	100%
Core #3:	68°C	27°C	71°C	100%

Always stress test your CPU before overclocking, to get a good reference point.

PICKING A COOLER

The first thing to consider after you've decided on overclocking is what you'll use to cool your components. To put it bluntly, the stock coolers that AMD and Intel provide simply won't cut it when it comes to dissipating the excess heat that comes from adding more voltage. They're designed to deal with what the processor can output at stock frequencies, and not a lot more.

SnowStorm
GELID
CC-SnowStorm-01

MAINGEAR
FORCE

AIR

The more traditional, easier solution would be to rely on air cooling for your CPU. There's a huge list of air coolers out there, but it's vital that you consider the size of the cooler versus the height of your RAM and the size of your case. The last thing you want is to buy a new heatsink for your shiny new i7-4790K, only to discover it won't fit over the top of your Corsair Dominator GTs. The Dark Rock Pro 3 is a particular favorite of ours—it's silent, yet can relieve your CPU of over 250W of TDP, plus it'll keep your bacon cool.

AIO WATER COOLING

The second option, and one we all prefer here at *Maximum PC*, is an all-in-one water-cooling loop. You've probably seen a lot of these kicking about, Corsair's Hydro H100i being the more famous of the bunch. These are a quick and easy solution, and often provide a great deal more cooling than a single air cooler, due to their increased surface area. They're also a lot less tricky to install (providing you have the radiator support), and can clean up your rig quite nicely while allowing you to swap out components with relative ease.

CUSTOM-LOOP COOLING

Finally, the fully custom loop. It's the dream, the crème de la crème, and the aspiration of every tech enthusiast starting out on the bumpy road to a successful overclock. It's also something that's become increasingly easy to build in recent years. Although certainly the most effective of the three, due to the ability to expand on your loop by adding more radiators, and cool more components, it can become very rigid, especially if you want to change out a graphics card, for example. It's definitely something that needs to be researched fully before committing to, if only because it can easily add up to $500 to your costs. And that's without the real premium components. But wow, does it look good when you're done. The Parvum Titanfall rig is a prime example of this.

MOBOS AND PSUs

Once you've got your cooling sorted out, you'll want to make sure you've got the best possible components that you can budget for in regard to stability. That means two items in particular—the power supply unit (PSU) and the motherboard. They are both imperatively important when it comes to overclocking. Perhaps most obvious is buying a motherboard that supports overclocking. For Intel, that's any motherboard with the Z97 chipset. For AMD users, it's currently any FM2 or AM3+ board.

Concerning power supplies, you want to be looking at a PSU that has at least 20 percent spare capacity, in terms of wattage, over what your system requires. Preferably, push as much money as you can into it. The higher-end power supplies not only feature better surge protection, but also provide a more consistent flow of electricity between the wall and your PC parts. This should result in longer life and more stability, both when overclocking and through everyday usage.

800W
Silent Pro Gold
msi

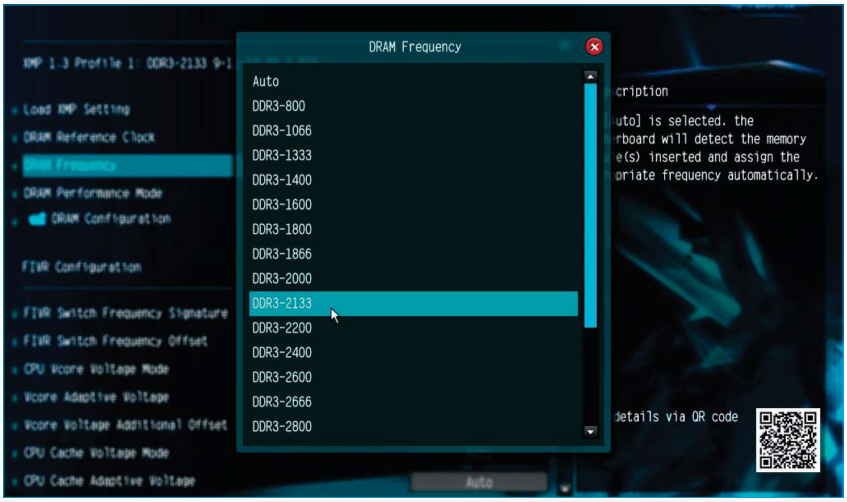
Overclocking Your RAM

Wait! There's more! Overclocking isn't limited to just your processor

Yes. It's true. Overclocking doesn't just mean tinkering with your CPU. Other avenues exist if you're keen to shove the boat out a little bit more.

RAM speeds over the course of the last few years have almost tripled in frequency, meaning performance can be improved quite dramatically in certain computational programs. It's important to bear in mind, however, that the higher you push your RAM frequency, the more your CPU will suffer. In other words, it might mean an overall lower final overclock for your little powerhouse.

On the other hand, AMD's APUs, despite being a lower-end graphics solution, will benefit hugely from an increase in those same frequencies. So, what does all this come down to?



```
XMP 1.3 Profile 1: DDR3-2133 9-1
Load XMP Setting
DRAM Reference Clock
DRAM Frequency
DRAM Performance Mode
DRAM Configuration
FIVR Configuration
FIVR Switch Frequency Signature
FIVR Switch Frequency Offset
CPU Vcore Voltage Mode
Vcore Adaptive Voltage
Vcore Voltage Additional Offset
CPU Cache Voltage Mode
CPU Cache Adaptive Voltage

DRAM Frequency
Auto
DDR3-800
DDR3-1066
DDR3-1333
DDR3-1400
DDR3-1600
DDR3-1800
DDR3-1866
DDR3-2000
DDR3-2133
DDR3-2200
DDR3-2400
DDR3-2600
DDR3-2666
DDR3-2800

cription
uto] is selected, the
rboard will detect the memory
e(s) inserted and assign the
priate frequency automatically.

details via QR code
```

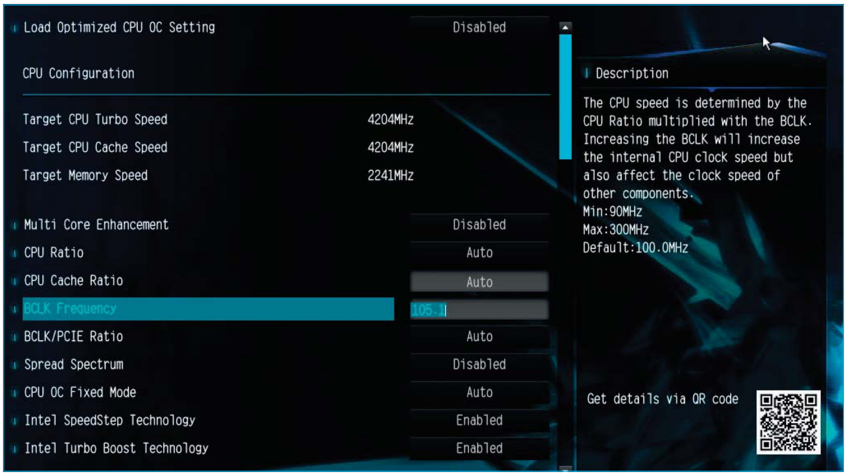
Motherboard support may vary here.

1 WHAT'S THE FREQUENCY?

Identifying the frequency of your RAM on purchase is crucial. We wouldn't go for anything less than 1,600MHz as a minimum if building a rig today. With Skylake and DDR4 around the corner, we'd be tempted to hold off a little and wait for that, as the price of the next generation of memory is still continuing to plummet.

2 THE PROFILE SETUP

We're using a pair of Corsair Dominator Platinums, clocked at a stock speed of 2,133MHz. To take advantage of any potential additional clock speed, you'll need to set up the memory with the correct profile on install. So, either Intel's XMP profiles or AMD's AMP profiles. This is exactly what we'll be using, just to do a slight overclock of the memory.



```
Load Optimized CPU OC Setting          Disabled

CPU Configuration

Target CPU Turbo Speed          4204MHz
Target CPU Cache Speed          4204MHz
Target Memory Speed             2241MHz

Multi Core Enhancement                 Disabled
CPU Ratio                              Auto
CPU Cache Ratio                        Auto
BCLK Frequency                         105.1
BCLK/PCIE Ratio                        Auto
Spread Spectrum                        Disabled
CPU OC Fixed Mode                      Auto
Intel SpeedStep Technology             Enabled
Intel Turbo Boost Technology           Enabled

Description
The CPU speed is determined by the
CPU Ratio multiplied with the BCLK.
Increasing the BCLK will increase
the internal CPU clock speed but
also affect the clock speed of
other components.
Min:90MHz
Max:300MHz
Default:100.0MHz

Get details via QR code
```

Pushing your CPU and RAM to the max.

3 UPPING THE FREQUENCY

Enter your BIOS by again headbutting the Delete key. Make sure you have either your XMP profile or your AMP profile selected, then change the memory frequency to one frequency higher than your memory's stock frequency. In all likelihood, your RAM should be able to manage and maintain that frequency, regardless of what the stock speeds say.

4 ABOVE AND BEYOND

If you want to take it further, this time we'll change the BCLK frequency, instead of adjusting a RAM multiplier. You can up this in very small increments. But it also ups your CPU's basic overclock, so if you've already OCed your chip to the absolute max, it's unlikely you'll be able to push the memory or the CPU any further.

Overclocking Your GPU

Last, but certainly not least, the final hurrah of overclocking

With DirectX 11, at least, OCing the GPU is the area of most benefit to gamers. But it's also where overclocking has most dramatically changed. That's because, with Nvidia's GPU Boost and AMD's Power Tune, it's no longer possible to simply up the voltage and in turn increase cards' core clock speeds.

It's now often better to ignore the voltage and let the proprietary software do its own thing. This way, you can avoid reaching the artificial power limits set by our GPU overlords—cores won't throttle themselves in an attempt to control imaginary temperatures, that may or may not be present, even if they're running on an aftermarket cooler, or water.

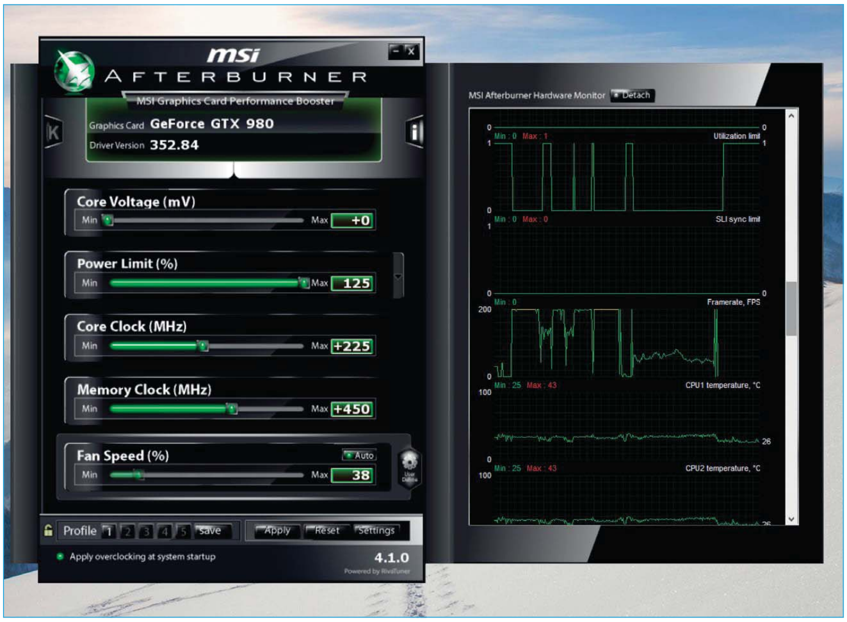
Sounds ridiculous, right? You're not wrong. Still, we'll show you how far you can go with these cards.

1 GET THE SOFTWARE

Unlike CPU overclocking, we need to download some proprietary software to use within Windows to overclock our cards. It's usually most beneficial to download whichever manufacturer's software your card's PCB is based upon. GPU Tweak for Asus, Afterburner for MSI, Precision for EVGA, and so on. In this case, we're using a reference cooler on our GTX 980, so we're using MSI's Afterburner, as it provides us with frame monitoring for benchmarking, a customizable display, and in-game overlays to monitor how well these cards perform in comparison to their stock speeds.

2 ENABLE MONITORING

Once Afterburner is installed, the first thing we want to do is enable in-game overlay, and frame rate monitoring, followed by (for us at least) changing the skin to something a little more workable.



Graphics Card GeForce GTX 980
Driver Version 352.84

Core Voltage (mV) +0
Power Limit (%) 125
Core Clock (MHz) +225
Memory Clock (MHz) +450
Fan Speed (%) 38

● Apply overclocking at system startup

Afterburner's in-game overlay makes it easy to monitor how your GPU is doing.

3 TEST STOCK SPEEDS

Next, you'll want to get a clear understanding of how your card performs at stock speeds. We're using *Total War: Rome II*'s benchmarking software, at maximum settings, at 2560x1440. We achieved a minimum frame rate of 19, a maximum of 61, and, more importantly, an average of 44.7.

4 INCREASE THE POWER LIMIT

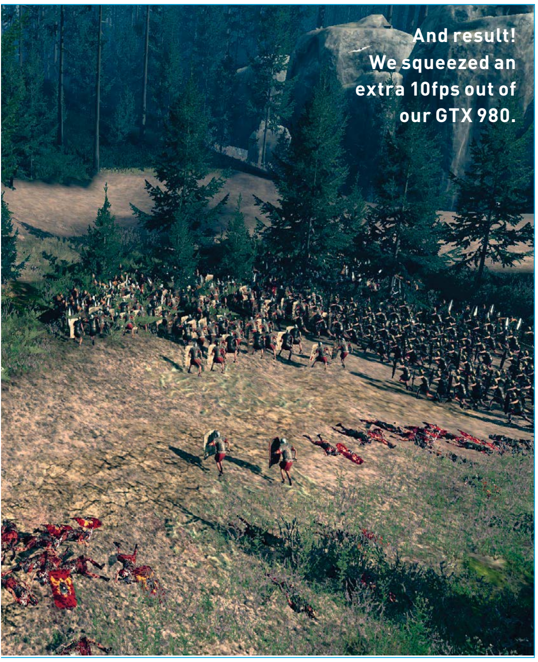
With the benchmarks and stock speeds out of the way, it's now time to get into the overclocking side of things. Head back to the desktop and open MSI Afterburner again. The first thing we're going to increase is the power limit. Move the slider to as high as it will go (usually 110 percent). This should allow our card to use absolutely every inch of power we can get, beyond Nvidia's recommended stock settings, meaning the card can run all the way up to 91 degrees Celsius, as opposed to the stock 79 C.

5 UP THE CLOCK SPEED

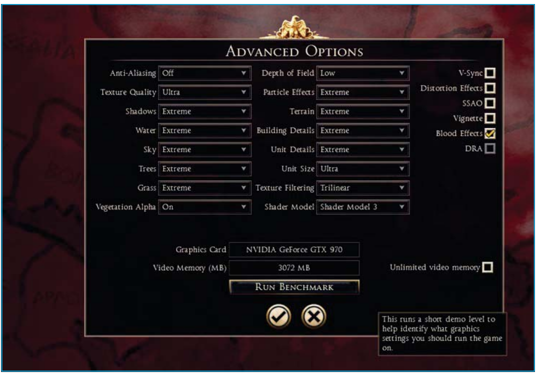
Start by increasing the clock speed. Research what's most suitable for your card. In our case, a healthy overclock for the core clock should be an extra 225–275MHz offset, so we go for 240MHz.

6 NOW, THE MEMORY CLOCK SPEED

Lastly, we're going to increase the memory clock speed. After research, we can see that the community,



And result! We squeezed an extra 10fps out of our GTX 980.



ADVANCED OPTIONS

Anti-Aliasing: Off
Texture Quality: Ultra
Shadows: Extreme
Water: Extreme
Sky: Extreme
Trees: Extreme
Grass: Extreme
Vegetation Alpha: On
Depth of Field: Low
Particle Effects: Extreme
Terrain: Extreme
Building Details: Extreme
Unit Details: Extreme
Unit Size: Ultra
Texture Filtering: Trilinear
Shader Model: Shader Model 3
V-Sync ☐
Distortion Effects ☐
SSAO ☐
Vignette ☐
Blood Effects ☑
DRA ☐
Graphics Card: NVIDIA GeForce GTX 970
Video Memory (MB): 3072 MB
Unlimited video memory ☐

This runs a short demo level to help identify what graphics settings you should run the game on.

***Total War: Rome II*'s benchmark tools are a lifesaver.**

on average, is aiming for around 450MHz. We'll try that and see how it goes, leaving Nvidia's GPU Boost to calculate exactly how much voltage we need for everything. All that's left to do is press "Apply" and go back into the benchmark to see how well the card now performs.

Remember, if something goes wrong, a quick reboot of the system will reset all of your overclock settings to default.

In the *Total War: Rome II* benchmark, we achieved a minimum frame rate of 17 at overclock, a maximum of 67, and, more importantly, an average of 53.6. That's an increase of almost 9fps for the average. Granted, the delta between the minimum and the average is considerably greater than the stockclocked version, but who can argue with free performance?

CPU BENCHMARKS

	Core i5-4670K Turbo to 3.8GHz	Core i5-4670K OC to 4.5GHz	Core i7-4790K Turbo to 4.4GHz	Core i7-4790K OC to 4.8GHz
Idle Temp (°C)	29	29	27	31
Load Temp (°C)	71	84	62	70
Cinebench	566	667	877	943
Total War: Rome II (min/avg/max fps)	19/40/59	16/40/53	16/42/58	17/42/57
Vcore	N/A	1.385	N/A	1.445

Tests carried out on max settings/shader model 4.1/1440p.

GPU BENCHMARKS

	Stockclocked GTX 980	Overclocked GTX 980
Total War: Rome II Minimum fps	17	17
Total War: Rome II Average fps	45	54
Total War: Rome II Maximum fps	57	67
3D Mark Firestrike Extreme	5,654	6,558

Tests carried out on max settings/shader model 4.1/1440p.

TEST BENCH SPECIFICATIONS

CPU	Intel i5-4670K / Intel i7-4790K
Motherboard	ASRock Z97 Extreme4
Memory	Corsair Dominator Platinum (2x 4GB) 2,133MHz
Graphics	Nvidia Geforce GTX 980
SSD	OCZ Arc 100 (240GB)
Power Supply	BitFenix Fury 750W

CONCLUSION

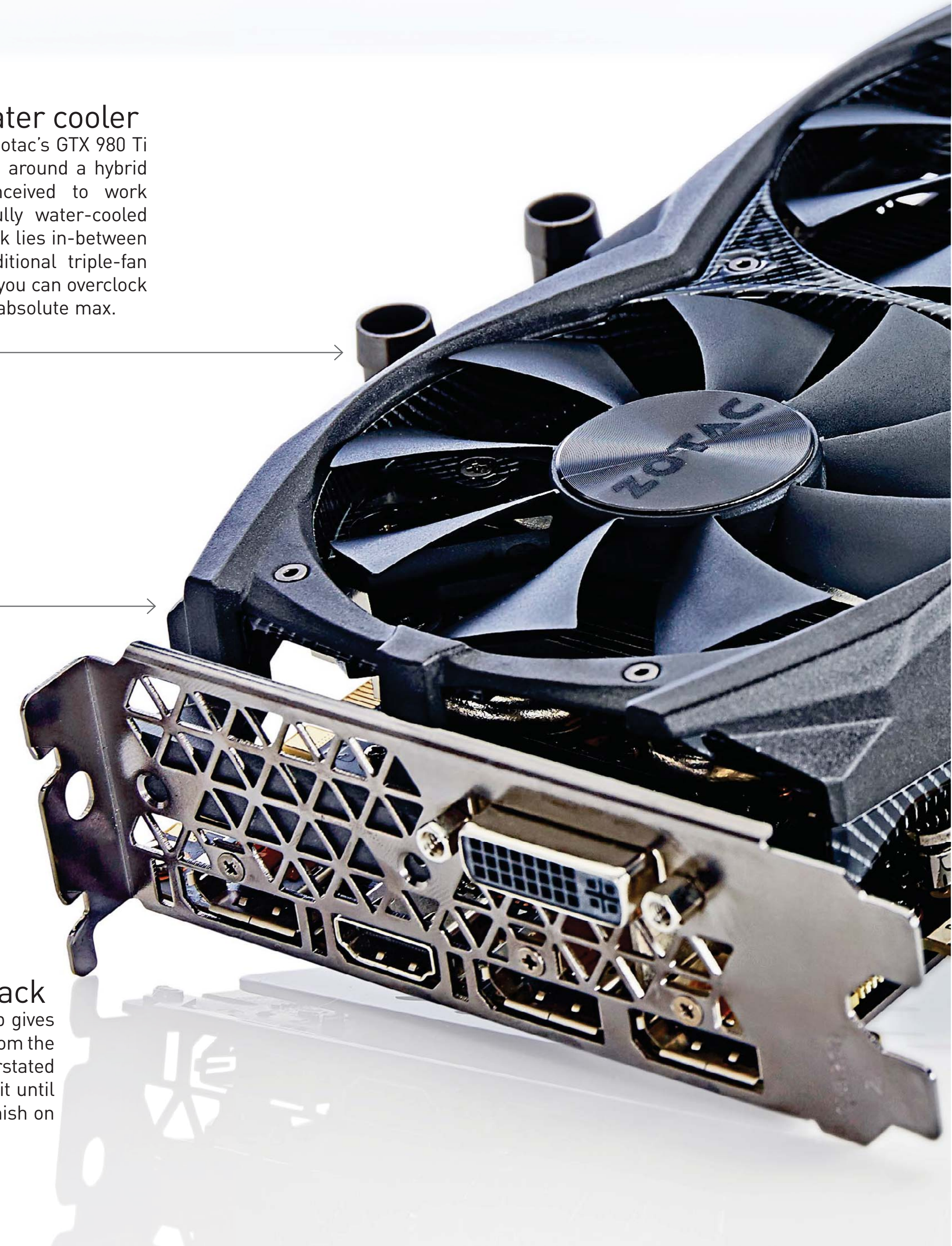
Welcome to the world of overclocking, a place where dreams are realized, and where having just enough of those overclocking chops may mean the difference between a world record–breaking benchmark and a night of crying into a pile of burned-out chips and GPUs.

As mentioned at the beginning of this guide, OCing isn't for the faint-hearted. You can do a considerable amount of damage to your CPU and other component parts, so it's not something to be taken lightly. What's more, in some cases, the performance gains are negligible. But, if you're interested in eking every last ounce of power from your machine, this is definitely the hobby for you.

It's something the vast majority of PC users will shy away from, and it's understandable why—the thought of placing extra strain on any of your components for the sake of a few more points in Cinebench hardly seems worth it at times. But when you're sitting there, in front of a stable 5GHz overclock on an ITX motherboard, with a chip being cooled by a single 120mm rad outperforming cores half its age, there's an odd sense of pride about it all. A bond between man and chip. Yes, we went there. ⏻

TECH PORN

PERFORMANCE GEAR LAID BARE



1 Hybrid water cooler

The design of Zotac's GTX 980 Ti Arctic Storm is based around a hybrid cooling system. Conceived to work optimally within a fully water-cooled loop, a copper heatsink lies in-between the GPU and an additional triple-fan cooler to help ensure you can overclock the 980 Ti chip to the absolute max.

2 Stealth black

Zotac's paint job gives the card a sleek look from the front. If it's a little understated for your liking, just wait until you see the custom finish on the back....

ZOTAC
ZOTAC
16235-6
251-20923-4300F

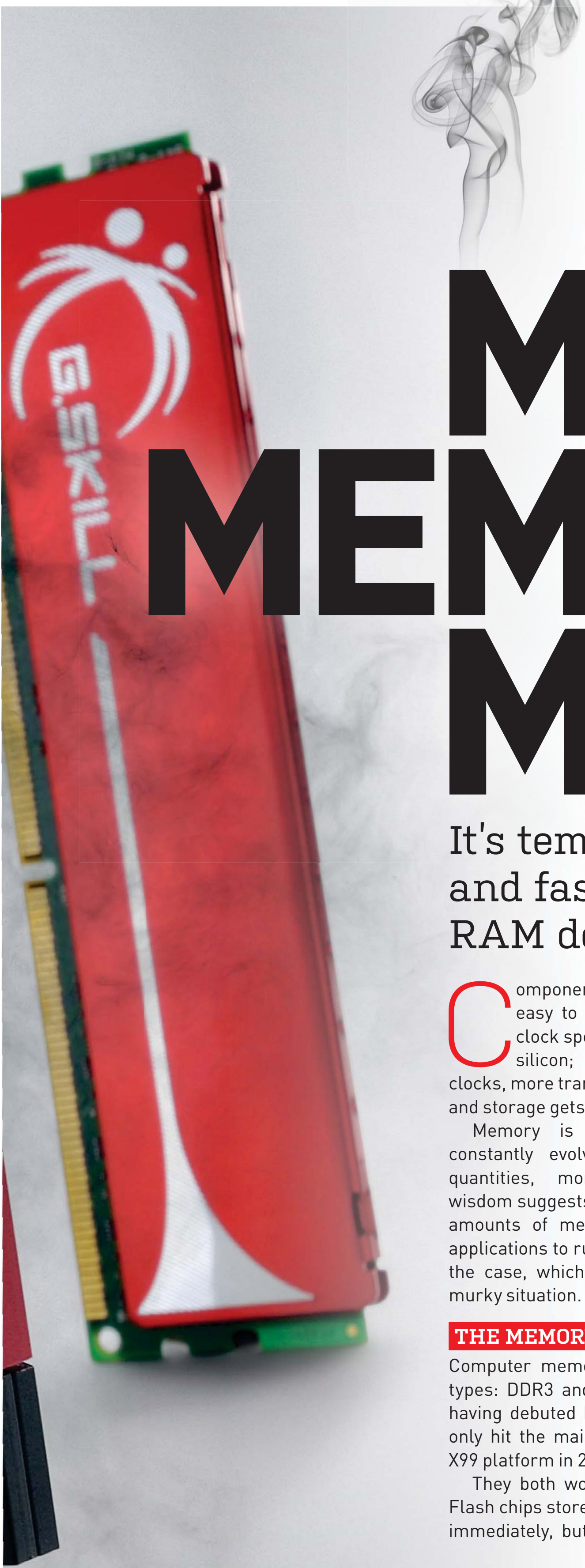
3 Triple-fan 0db design
The fans won't start spinning until the card reaches a temperature worth cooling, meaning silence-optimized pwning of all the noobs.

Zotac GTX 980 Ti Arctic Storm

SINCE THE RELEASE of the Titan X, many of us have wondered whether Nvidia would even bother releasing the 980 Ti. But low and behold, Nvidia has launched possibly one of the best bang-for-your-buck GPUs ever. A card that, although inheriting only a portion of the Titan X's processing power and half of its memory, performs only slightly below the $1,000 beast. Throw an overclock on that and you've a hugely competitive card.

So, what did Zotac do with Nvidia's new graphics card? Simple, strap a water-cooling block to it, add an additional triple-fan heatsink, and overclock the balls out of it. This card is beyond insanity. It weighs a ton, but that's mostly down to the fully copper waterblock tucked away inside. It's so heavy, in fact, that Zotac ships a brace with it just to make sure the behemoth doesn't demolish your motherboard. –**ZAK STOREY**

crucial
Ballistix Tracer
DDR3
GeIL
EVOTWO



MUSCLE MEMORY MYTHS

It's tempting to always get the biggest and fastest memory kit, but how much RAM do you actually need?

By Mike Jennings

Component lifespans are usually pretty easy to track. Processors get higher clock speeds, more cores, and smaller silicon; graphics cards get better clocks, more transistors, and bigger heatsinks; and storage gets bigger and cheaper.

Memory is another component that's constantly evolving: faster speeds, bigger quantities, more channels. Conventional wisdom suggests that adding faster and larger amounts of memory will allow games and applications to run faster, but that's not always the case, which is why we've examined this murky situation.

THE MEMORY LANDSCAPE

Computer memory is divided into two main types: DDR3 and DDR4. The former is older, having debuted back in 2007, while the latter only hit the mainstream recently, with Intel's X99 platform in 2014.

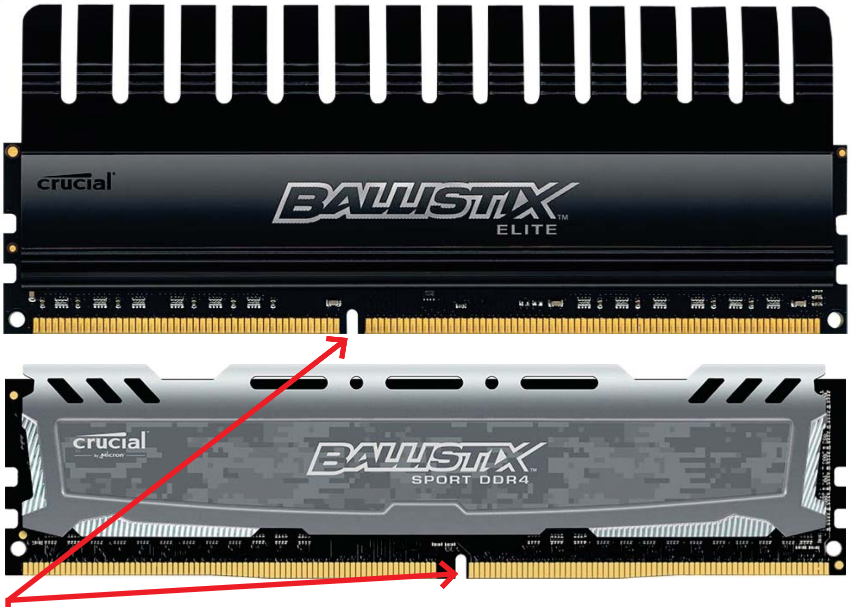
They both work using the same principle: Flash chips store data that the computer needs immediately, but it's lost when it's no longer useful or the PC is turned off. It's governed by several common attributes: Larger amounts mean more data can be stored, and higher MHz ratings mean the memory runs at a faster speed, so data moves in and out more rapidly.

The newer standard, DDR4, has several advantages over DDR3. It runs at a higher frequency, so it's able to process tasks at a faster rate: DDR3 is generally clocked between 1,333MHz and 2,400MHz, while DDR4 ranges from 2,400MHz to 3,200MHz. It's possible to blur these lines with overclocking, but, for the most part, DDR4 is faster. It balances those better speeds with more efficient power consumption, and its chips have double the internal memory banks, faster burst access, and higher data transfer rates.

DDR3 and DDR4 memory work with different motherboards and chipsets. DDR3 memory is compatible with virtually every motherboard and socket type you're able to buy right now, but DDR4 memory is only compatible with boards that use Intel's X99 chipset and LGA 2011 processor socket.

DDR4, however, does have one downside. That's increased latency. Newer DDR4 2,133MHz memory has a latency rating of CL15, which means it'll take 14.06ns to perform a read, while DDR3 1,600MHz memory reads at 13.75ns. That's a tiny margin, and DDR4 negates this disadvantage with its generally higher clock speeds. Nevertheless, if you'd like to keep an eye out, look for CAS ratings. This indicates latency, and lower is better.

No matter which memory you buy, you'll have to deal with channels. Dual- and quad-channel setups are the most popular and improve performance by allowing motherboards to use multiple channels to send and receive data simultaneously, therefore improving bandwidth. It's possible to run memory in single-channel mode, but there'll be a performance decrease if you run a single stick of memory rather than two or four.



Different locations of the key notch (on the insertion edge of each DIMM) prevents a DDR3 (top) or DDR4 stick (bottom) from being installed into an incompatible board or platform.

THE CHANGING PC LANDSCAPE

The variety of different specifications means that prices vary wildly. The cheapest 16GB DDR3 kits made from two 8GB sticks currently cost about $100, but the most expensive can cost more than $300. It's a similar story with DDR4, which dual- and quad-channel kits also vary by huge amounts when it comes to price. But these will always be more expensive than their DDR3 equivalents.

Manufacturers claim that the increased speeds and better features provided by pricier memory will make a dramatic difference to performance, but we're not so sure, so we've set up some test rigs to find out just how much memory you really need.

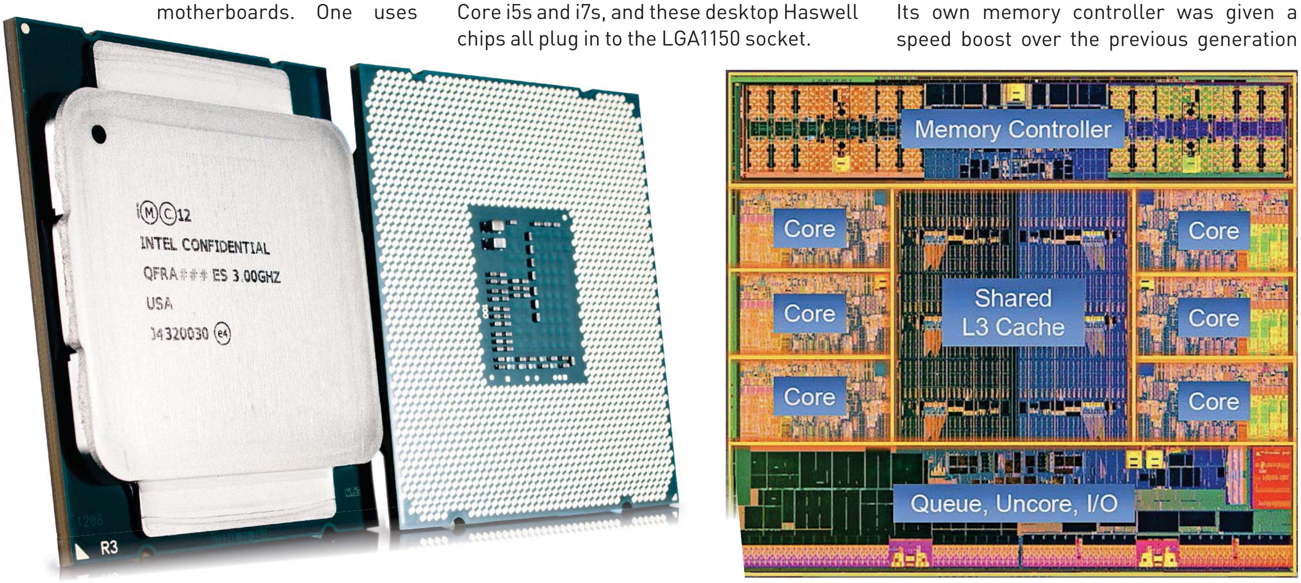
Both of the test rigs we've set up use MSI motherboards. One uses Intel's Z79 chipset with a Core i7-4770K processor, while the other is an X99 rig with a Core i7-5820K chip. Both use operating systems installed on a Samsung 850 Evo SSD, and both use an Nvidia GeForce GTX 980 graphics card.

We've already mentioned the different processors and chipsets that work with DDR3 and DDR4, but there's more to choosing components than just making sure your new gear is compatible on paper. Intel's Haswell architecture is behind the bulk of its current desktop processors, and it was its first to include native support for dual-channel memory, with up to 32GB of RAM. It's used for chips that range from cheap Celerons and Pentiums to expensive Core i5s and i7s, and these desktop Haswell chips all plug in to the LGA1150 socket.

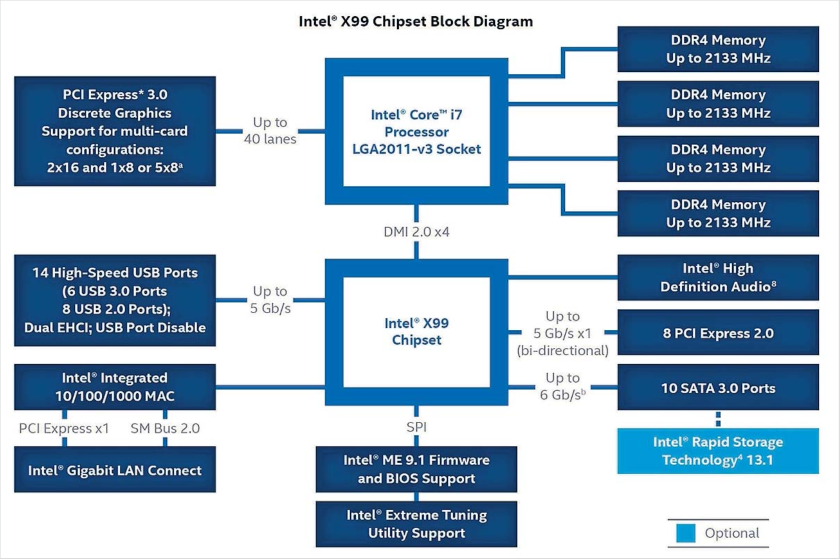
Most Haswell-based processors are deployed with mobos that have Intel's H87, Z97, and Z87 chipsets. When it comes to memory support, they're all impressive. They handle four slots that accommodate two sets of dual-channel memory, and most full-size ATX boards also support 32GB or 64GB of memory at rapid speeds.

Intel has further developed its architecture with Haswell-E. Chips that use this system also use the LGA2011 socket and X99 chipset, which means that support for DDR4 is included—and so, in turn, that means support for faster quad-channel memory when compared to DDR3.

AMD's processors and APUs, meanwhile, use the Piledriver architecture. Its own memory controller was given a speed boost over the previous generation



Chips using Intel's Haswell-E architecture use the LGA2011 socket and X99 chipset, meaning support for DDR4 is included. That's great news if you do a lot of encoding or rendering, but it won't make a huge difference to gamers.


Intel® X99 Chipset Block Diagram
PCI Express* 3.0 Discrete Graphics Support for multi-card configurations: 2x16 and 1x8 or 5x8[a]
Up to 40 lanes
Intel® Core™ i7 Processor LGA2011-v3 Socket
DDR4 Memory Up to 2133 MHz
DDR4 Memory Up to 2133 MHz
DDR4 Memory Up to 2133 MHz
DDR4 Memory Up to 2133 MHz
DMI 2.0 x4
14 High-Speed USB Ports (6 USB 3.0 Ports 8 USB 2.0 Ports); Dual EHCI; USB Port Disable
Up to 5 Gb/s
Intel® X99 Chipset
Intel® High Definition Audio[8]
Up to 5 Gb/s x1 (bi-directional)
8 PCI Express 2.0
Up to 6 Gb/s[b]
10 SATA 3.0 Ports
Intel® Integrated 10/100/1000 MAC
PCI Express x1
SM Bus 2.0
Intel® Gigabit LAN Connect
SPI
Intel® ME 9.1 Firmware and BIOS Support
Intel® Extreme Tuning Utility Support
Intel® Rapid Storage Technology[4] 13.1
Optional

The X99 chipset introduced DDR4 to the (high-end) mainstream market, bringing with it faster clock speeds and better power efficiency, but with increased latency.

of AMD hardware, but memory support ultimately still isn't as good on this side of the fence. All of AMD's current chips support DDR3 memory, however, some of them are restricted to 1,600MHz or 1,866MHz memory, while only a handful top out at 2,133MHz. Like Intel, these boards do support dual-channel memory.

DON'T FORGET YOUR MOTHER

Processors and chipsets aren't the only bits of your PC that need to be checked before shelling out for new memory—motherboards are also vital. You'll need to make sure a board has the right number of slots, and also check what amount and speed of memory it can accept: It's no good dropping a few hundred bucks on a 32GB 3,000MHz kit if your motherboard taps out at 16GB and 2,666MHz.

There are nuances to be examined, then, but for the most part, the memory landscape is heartening. No matter what processor, chipset, or motherboard you use, you'll be able to equip a rig with plenty of high-end memory at decent speeds. That's good for PC building, but it's not necessarily great news for companies that rely on flogging expensive, high-end kits.

Future developments from Intel and AMD will only improve the situation. Intel's next architecture, Skylake, will support DDR4 across all of its full-fat desktop chips, but it'll also be backward-compatible with DDR3, which adds a huge amount of versatility. We also expect to see improvements to the memory controller and support for larger amounts of memory running at faster speeds.

AMD isn't standing still, either. Its next proper desktop architecture is called Zen, and it'll offer full DDR4 support to bring the company's chips alongside Intel.

DDR3 MEMORY: HIT AND MISS

The first set of DDR3 benchmarks we locked and loaded were PCMark 8's Home, Creative, and Work tests—a trio of suites that simulate the kind of low-intensity tasks that take place on many systems, from web browsing and video chatting to word processing and spreadsheets.

Our first tests deployed the bare minimum of sluggish DDR3: 8GB of RAM clocked to 1,333MHz. With this RAM, the rig returned scores of 5,170, 6,794, and 5,234 points, in the Home, Creative, and Work tests, respectively. However, with 8GB of 1,600MHz memory deployed, the scores barely improved, with the Creative run only jumping to 6,852.

There wasn't even much of a difference in these tests when we installed 16GB of 1,866MHz memory: In those three benchmarks, the machine scored 5,270, 6,961, and 2,525. The biggest leap came in the Creative test, which suggests more memory helps with photo editing and

> "No matter what CPU or mobo you use, you'll be able to equip a rig with high-end memory."

THE AESTHETICS OF MEMORY

Memory manufacturers try to sell expensive kits on the basis of their size or speed, but that's not the only advantage that comes from spending big on a high-end set of DIMMs—many of them are also designed to look better than their cheaper, plain-looking alternatives.

Corsair's Dominator Platinum range sits at the top of the firm's product stack, and some of its key benefits are about the visuals. Corsair boasts of its industrial design and LED lighting—the top metal bar can be upgraded with different attachments, the LEDs can be changed, and the box has a good-looking fan kit that can sit on top of the sticks to provide extra cooling.

Expensive memory kits like this don't just have aesthetic advantages—Corsair's Dominator Platinum chips are hand-sorted, have improved monitoring hardware, and better heatsinks. But there's no denying the visuals play a part when it comes to high-end memory.

Other firms offer similarly high-end extras. Crucial's Ballistix memory sticks have attractive aluminum heatsinks alongside practical extras like integrated thermal sensors, while Kingston's HyperX Predator and Beast products have good-looking exteriors, but are chosen specifically to provide the best performance.

Kits like this bring practical and visual improvements to the table, then, but they're not always necessary. If you're building a midrange rig, or want to put together a machine without a window in its case panel, they're simply overkill.

Kingston's HyperX Beast boasts more than just good looks.

HYPERX BEAST
Kingston

VULNERABLE
PRESIDENT
PERSONA
AIRSH
AT THE
BALLISTIX
SPORT DDR4

Whether you've got DDR3 or DDR4, upping the size or speed of your memory makes little difference to *Bioshock Infinite*. Crucial's Ballistix sticks, left, look good, but also come with handy extras, such as integrated thermal sensors.

other trickier tasks, but it's hardly a game-changing jump in performance.

We saw similarly modest gains in other photo-related applications. GigaPan Stitch knits together a group of high-resolution photos, and our test image took four minutes and 12 seconds to complete in a rig with 8GB of 1,333MHz memory. That only improved by 11 seconds when we doubled the RAM and upped its speed to 1,866MHz.

Other application benchmarks saw similarly modest impacts. A Cinebench R15 CPU test with two 4GB, 1,600MHz sticks returned a result of 703; doubling the memory and improving its speed to 1,866MHz only improved that figure to 751.

We only saw big improvements in a few benchmarks when running DDR3 tests. In PCMark Vantage, our 8GB 1,600MHz rig scored 18,313 points, but doubling the memory and running it at 1,866MHz saw that result jump by almost 3,000 points—a significant increase.

Indeed, our theoretical tests indicate that improving memory amounts and speeds does make a difference, but that these gains don't generally translate to real-world tests.

In SiSoft Sandra's multithreaded bandwidth test, our 2x 4GB 1,333MHz setup scored 16.57GB/s, but doubling the memory and improving its speed to 1,866MHz saw that result jump to 23.33GB/s. There was a decent jump in single-threaded bandwidth, and cache bandwidth also improved significantly when faster memory was added in larger amounts.

The leap from dual-channel to quad-channel memory doesn't often have much of an impact on our application tests, either. In Cinebench R15's OpenGL test, a machine with two 4GB 1,600MHz sticks scored 111 frames per second, with this score only jumping to 117fps with four 4GB 1,600MHz sticks installed.

When running applications using DDR3, then, the differences between slow and fast memory often aren't huge—and, as long as you've got 8GB of memory installed, then you're going to have enough to get most stuff done in real-world situations.

There was a noticeable performance difference between our rig with 1,333MHz and 1,600MHz memory installed, but, once beyond that 1,600MHz speed, the gaps between different memory speeds narrowed rapidly. We ran GeekBench single-core benchmark on 1,600MHz memory, and then again at 2,800MHz memory, but its result only improved by around 100 points.

The benchmarks demonstrate that there are performance gains to be had by installing more memory at faster speeds, but those gains are only noticeable in high-end applications. For most of us, 8GB or 16GB of 1,866MHz memory will be more than enough.

DDR3 AND GAMING

We tested a variety of games using our DDR3 rig, but only found sporadic improvements. In *Metro: Last Light*, a machine with two 4GB 1,333MHz sticks averaged 126fps, but improving to a pair of 8GB 1,866MHz DIMMs saw that result jump to 144fps.

In both *Bioshock Infinite* and *Batman: Arkham Origins*, though, the improvements were far less impressive—a few frames better in the minimum frame rate benchmark, and only a gain of 2fps to the average rate.

There also wasn't much of a difference in any of our Unigine Heaven

Batman is unimpressed by the speed of your computer memory.

Metro: Last Light **was our only DDR3 gaming test to noticeably improve with more memory.**

4.0 tests. In all of our DDR3 tests—ranging from a system with two 4GB 1,333MHz sticks to a machine with four 8GB 1,600MHz DIMMs—the benchmark's average frame rate hovered between 63.4fps and 66.8fps. Those configurations didn't differ much in 3D Mark's Fire Strike test either: in the same range of memory setups, our results only jumped between 11,607 points and 11,635 points.

THE DDR4 DIFFERENCE

Newer DDR4 memory operates with faster speeds, better channel support, and Intel's latest chipset and controller, so we expected our tests to reveal bigger performance disparities.

Our initial tests, though, appeared to follow the blueprint already set out by the older DDR3 sticks. In the Cinebench R15 CPU test, a machine with two 4GB 2,400MHz sticks scored 1,143 points. Doubling the memory and increasing its speed to 3,000MHz, however, only saw that result jump to 1,190.

The X264 video-encoding test led to similar patterns. Our more modest rig ran through its two tests at 205 frames per second and 68 frames per second, but increasing the memory's speed to 3,300MHz saw those results only inch forward to 211fps and 73fps—hardly a jump that'll make a big real-world difference.

GigaPan Stitch's photo-editing tool only saw a couple of seconds' worth of improvement with its memory sped up, while Geekbench exhibited similarly small gains: Our first DDR4 rig scored 22,165 points, but doubling the memory to 8GB, running at 2,666MHz, only saw the score jump to 22,849.

It's a shame because, as with DDR3, theoretical tests illustrated that improving speeds and amounts did make a difference. When we had two 4GB 2,400MHz sticks installed, our test rig delivered 15GB/s and 28.58GB/s of single- and multithread bandwidth, with those numbers jumping to 17GB/s and 32GB/s with those same sticks clocked to 3,300MHz.

Those same benchmarks illustrated how DDR4 copes with quad-channel and larger amounts of memory: Our machine with two 8GB sticks may have delivered 32GB/s of multithreaded bandwidth, but doubling the memory saw that figure leap to 45GB/s.

Quad-channel delivered impressive numbers throughout our benchmarks,

> **"Once beyond that 1,600MHz speed, the gaps between different memory speeds narrowed rapidly."**

PENTIUMS, CELERONS, AND APUs: BUYING MEMORY FOR A BUDGET PC

Our tests have examined the effect of different memory on high-end machines, but if you're building a budget rig, then different considerations should come to the fore at checkout time.

For starters, don't splash out on an expensive, fast memory kit if you're going to be constructing a PC built around one of Intel's Haswell-based Celeron or Pentium chips, as most of these only support DDR3 that runs at 1,333MHz. That's slow enough to cause a performance hit in many tests, but on a low-end rig, it's unlikely you'll be running the sort of applications that'll suffer with lesser speeds.

AMD's APUs are more accepting to faster memory, but you'll still need to pay attention to speeds. A couple of its cheapest parts only handle 1,333MHz or 1,600MHz DDR3, but most can support 1,866MHz sticks. It's the same on the CPU side, with FX chips mostly supporting 1,866MHz parts.

There's one other main consideration when putting together a budget machine: the motherboard. Budget boards don't often support the extreme speeds offered by pricier components, and many—especially at smaller form factors—only have two slots, rather than four. That's fine if you're building a system you don't intend to upgrade, but it can prove restrictive if you want to add more memory later.

Don't bother with high-end memory if you're running an A10-7850K or Pentium K.

then, but those figures weren't always translated to real-world tests. So, we'd say that it's not a vital addition to your PC, unless you're keen on buying a Haswell-E system to run intensive work applications or the most demanding games.

DDR4 AND GAMING

We saw a big jump in just one of our gaming benchmarks, *Metro: Last Light*, while testing with DDR3. However, updated DDR4 memory proved even less dramatic. Improving the amount and speed of memory saw our *Metro: Last Light* results jump by a mere couple of frames, and our biggest improvements in *Bioshock Infinite* and *Batman* also only saw increases of a frame or two, no matter the amount or speed of DDR4.

We'll let Unigine Heaven have the last word. Our rig averaged 62.7fps with two 4GB 2,400MHz sticks installed, but this only improved to 64.2fps once we installed four 8GB 2,666MHz DIMMs.

There's no doubt about the pure, naked speed of DDR4, but it looks like we're at the point, for gaming especially, where any 8GB dual- or quad-channel configuration will be ample. Memory simply isn't the bottleneck in gaming. Processors and graphics cards are the components that are more likely to be holding back your frame rates.

We used X99 (left) and Z97 (right) motherboards from MSI to carry out our benchmarks.

WHAT MEMORY DO YOU REALLY NEED?

It's tempting to buy the fastest and largest memory kit you can afford when putting together a new build, but, as many of our benchmarks illustrate, aiming for the top of the tech tree is actually an unnecessary extravagance when it comes to memory.

The story is the same whether you're creating a PC to use DDR3 or DDR4. A decent amount like 8GB or 16GB running at a reasonable speed will be enough to handle most tasks you throw its way, whether it's for work or gaming. You'll still see benefits if you buy larger and faster kits, sure, but they'll be less significant—so, it's only worth looking toward these kits if you're a true enthusiast who wants the best parts available or if you're running unusually demanding software and need to wring every last bit of performance from your PC.

Quad-channel kits, meanwhile, are great if you're using applications that'll truly take advantage of DDR4's improved architecture, such as encoding or rendering, but most people won't feel the benefit. It's no surprise, then, that it's only available with expensive X99-based CPUs.

The majority of PC users, even enthusiasts, just don't need to cough up for the priciest kits around, and that's definitely no bad thing. Memory, processor, and chipset developments have leveled the playing field, which means it's one less component to worry about when putting together a new PC.

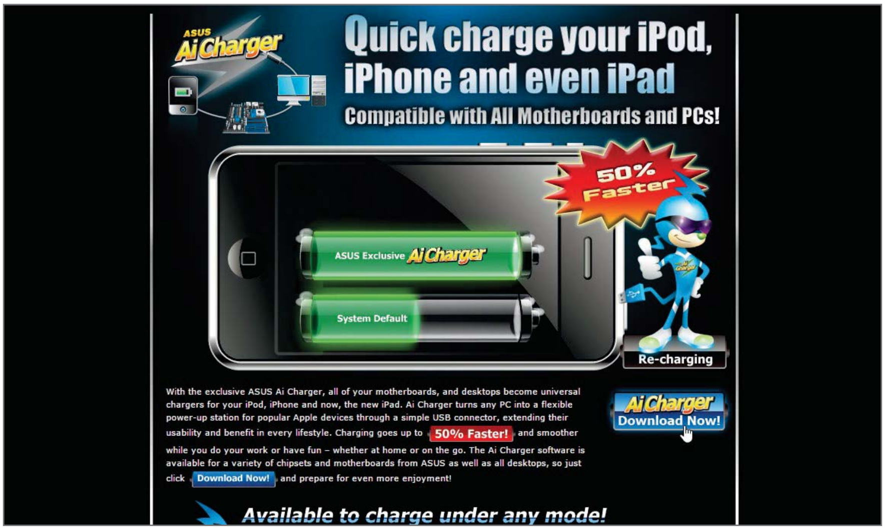
BENCHMARKS	**DDR3**				**DDR4**	
	8GB (2x 4GB) **1,600MHz** AMD AE34G1609U2	**8GB** (2x 4GB) **1,333MHz** Corsair CMV8GX3 M2A1333C9	**16GB** (2x 8GB) **1,600MHz** CML16GX3 M2A1600C9	**16GB** (2x 8GB) **1,866MHz** Crucial Ballistix Sport XT	**8GB** (2x 4GB) **2,400MHz** Kingston HX424 C15FBK4/32	**16GB** (2x 8GB) **2,666MHz** Ballistix BLE2C8 G4D26AFEA
Cinebench R15 (index)	703	738	**751**	721	740	**747**
PC Mark 8 (index)	5,161	5,170	5,228	**5,270**	5,320	**5,364**
PC Mark Vantage (index)	18,313	19,718	**20,944**	20,427	26,541	**28,088**
3DMark Firestrike (index)	11,624	11,607	11,608	**11,635**	11,820	**11,920**
X264 v4.0 (fps)	66.6	66.1	69.3	**69.4**	68.6	**72.6**
SiSoftware Sandra Memory bandwidth (GB/s)	21.1	16.6	20.6	**23.3**	28.6	**31.8**
Gigapan Stitch (secs)	248	254	242	**241**	245	**244**
Bioshock Infinite (min/avg fps)	11 / 109	11 / 115.9	11.6 / 115.3	**13.2 / 117.6**	33.2 / 122.6	**44.5 / 124.7**
Batman: Arkham Origins (min/avg fps)	100 / 135	99 / 137	103 / 137	**106 / 139**	**104 / 136**	104 / 133
Unigine heaven min/avg (fps)	26.5 / 64.1	25.2 / 63.4	**26.8 / 63.6**	26.2 / 63.6	**28.6 / 62.7**	27.8 / 62.7

Best scores are bolded.

HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

WINDOWS TIP OF THE MONTH


ASUS Ai Charger
Quick charge your iPod, iPhone and even iPad
Compatible with All Motherboards and PCs!
50% Faster
ASUS Exclusive Ai Charger
System Default
Re-charging
Ai Charger Download Now!
Available to charge under any mode!

With the exclusive ASUS Ai Charger, all of your motherboards, and desktops become universal chargers for your iPod, iPhone and now, the new iPad. Ai Charger turns any PC into a flexible power-up station for popular Apple devices through a simple USB connector, extending their usability and benefit in every lifestyle. Charging goes up to 50% Faster! and smoother while you do your work or have fun – whether at home or on the go. The Ai Charger software is available for a variety of chipsets and motherboards from ASUS as well as all desktops, so just click Download Now! and prepare for even more enjoyment!

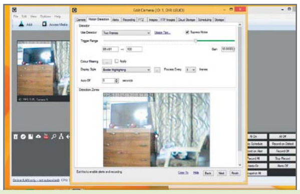
POWER-UP YOUR USB SOCKETS

Frustrated with your devices charging slowly via your PC's USB socket? The Asus Ai Charger can speed up the process. This free Windows utility ups the ampage of USB ports, so batteries should recharge as quickly as they would via the mains. Asus says it only works with Apple iPhones, iPads, and iPods, but reports suggest some success with Android devices. Find it at http://bit.ly/1g6LIGD.

MAKE – USE – CREATE

Boot Option #1
USB: SMI USB DISK 1100
USB: KingstonDT 101 G2 PMAP
USB: SAMSUNG HM120JC 0000
Disabled

62
Save your data from a dying PC



66
Set up your own CCTV system

70
Build an Oculus Rift-ready PC

GRAHAM BARLOW
CONTRIBUTING EDITOR

THE WAIT FOR WINDOWS 10 NEARS END

Patience may be a virtue, but like most tech-heads, I don't possess it. I want the latest gadgets, and I want them yesterday. Unsurprisingly, I couldn't wait for the official release of Windows 10. I grabbed the Insider Preview and put the new OS through its paces early. And already, its ability to kick Windows 8's ass from Redmond to Cupertino, and back, is pretty clear. In particular, the new Start menu skilfully combines the best bits of Windows 7 and 8 into an OS that actually works!

Of course, you'll want to own your Start menu completely, and Microsoft, wisely, lets you. Adding an application is easy, and follows the same route as Windows 8. You can also make your Start menu look more presentable, by resizing and moving the apps around. Then there's Live Tiles, which you can switch off or on, add to, rename, resize, and much more. We've got a tutorial on page 65 with all the step-by-step details.

Overall then, it all looks pretty good, and if the Insider Preview is anything to go by, you're going to love Windows 10. It's time you booked an upgrade. Windows 10 goes on general release oh-so-soon, on 29 July, and is available free of charge to anybody running Windows 7 or 8.

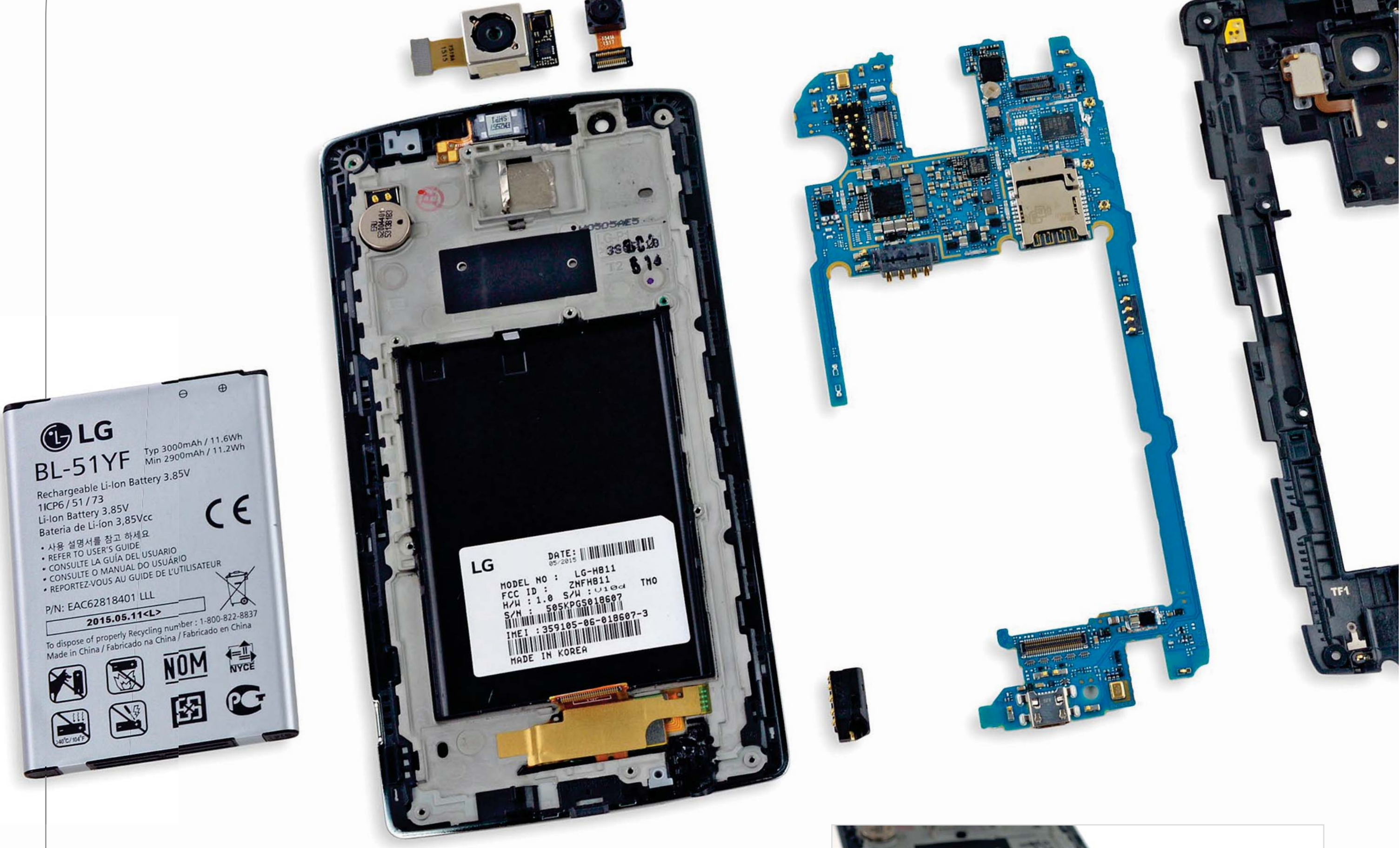
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

LG G4

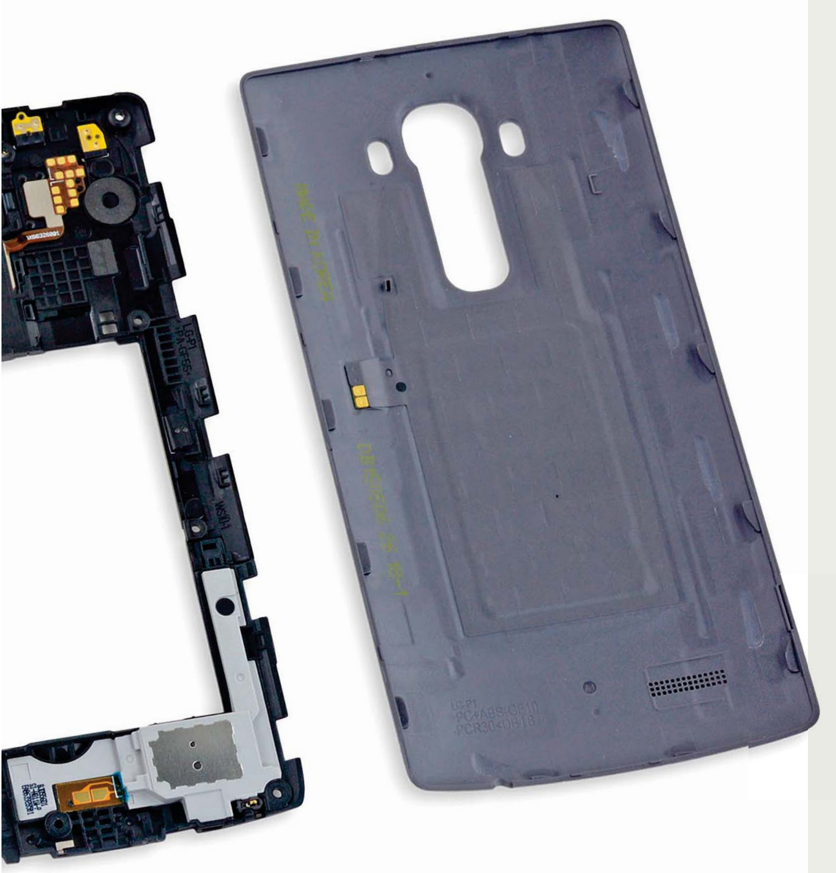


About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

Damage your headphone jack? No problem! Cool spring contacts make for easy replacement.

The LG G4 is very easy to take apart. Tweezers and a Phillips screwdriver are all the tools you need.



Your own homegrown digits are all you need to get inside the back panel and swap out the battery.

BACKGROUND:

LG wasn't known for its super high-end Android flagships until it launched its widely-lauded G3 smartphone. Its successor, the G4, now looks to improve and expand upon a lot of that signature phone's features. But the big question is, how easy is it to take apart and repair?

MAJOR TECH SPECS:

- 5.5-inch IPS WQHD display (2560x1440 at 538dpi)
- 6-core, 1.8GHz, 64-bit Qualcomm Snapdragon 808 processor
- 3GB RAM; 32GB on-board storage, expandable to 2TB via microSD card
- 16MP rear camera and 8MP front camera.
- 802.11 a/b/g/n/ac wi-fi and NFC connectivity
- Android 5.1 Lollipop

KEY FINDINGS:

- If you need to swap out the battery on the LG G4, it's as easy as pie. Just unclip the back of the phone and replace it as you like. It's very convenient and similar to the old Samsung Galaxy S4, so no tools required. Nice.
- Unfortunately, the LG G4 doesn't support wireless charging without a specialized case. Although the snap back reveals that it does have special contacts peeking out of the plastic, these are the NFC antennas, not a wireless charging coil.
- You will need a Phillips #0 screwdriver to get into the guts of the phone, but there's still no tri-wing screws or any other ridiculousness from LG—it's a simple matter of grabbing an opening pick and slowly easing the midframe out to reveal the inner workings.
- The 8MP selfie camera is quick and easy to remove. The main feature here is the rather controversial smoothing effect, which can be useful if you're not shooting anything that requires high levels of detail. Additionally, LG has included a super-thin 0.1mm blue IR filter to reduce infrared interference, supposedly to give photos a more authentic feel.
- The headphone jack is easily removable once you grab your trusty set of tweezers. The jack has spring contacts, which make it easy to replace as there's no soldering or fuss to deal with, just snap in to replace. It's certainly a great deal easier to fix than headphones or earbuds.
- Repairability Score: 8 out of 10 (10 is easiest to repair). The rear panel and battery can be removed using only your hands. Many of the components are modular and can be replaced independently, You only need a standard Phillips #0 screwdriver, which should be easy to find. However, the fused-display assembly means you'll have to replace the entire screen if either the glass or the LCD breaks.

Recover Data If Your PC Fails

YOU'LL NEED THIS

MACRIUM REFLECT
Get the free recovery software from http://bit.ly/1gGwliJ.

EXTERNAL DRIVE
Ideally, an external USB 3.0 hard drive with enough space to hold the contents of your entire PC.

WHAT HAPPENS IF YOU CAN'T BOOT INTO WINDOWS? If, as in most cases, the hard drive itself hasn't physically died, then your data is tantalizingly close, but just out of reach. Attempting repairs could make things worse, but if you follow this tutorial, you'll be able to back up all of the data on your drive using a free program called Macrium Reflect Free, before you try to fix the problem.

This tutorial assumes you're unable to boot into Windows, in which case you'll need access to another Windows PC. You'll also need an external USB hard drive to recover your non-functioning drive's files to, plus rescue media in the form of a blank CD/DVD or spare USB flash drive (512MB in capacity or greater). Even if your PC is working perfectly for now, why not protect yourself and create the all-important rescue media now? It's easy to do in six steps (see "Create Rescue Media Now!" on page 64). It could save your files one day. **–NICK PEERS**

1 TOOLING UP

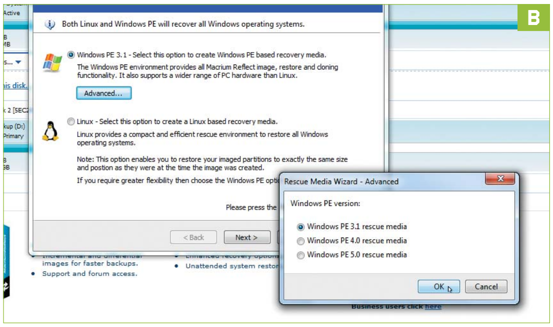
From a working PC, first download Macrium Reflect Free from www.macrium.com/reflectfree.aspx. Click the "Download now" link to get the software via Cnet. Save the file "reflectdl" to the hard drive, then double-click it to launch the installer. Make sure the selected download is the free version with PE 3 components. Click "Download" and follow the prompts.

» You'll need an external USB hard drive to store the recovered data [**Image A**]. It needs enough free space to hold the contents of the entire PC—Macrium will compress the backup, but it may not be enough. A new 1TB hard drive costs around $50, and is a worthwhile investment. Plug your USB hard drive into the working PC, which will detect it and install the necessary drivers.

2 LAUNCH RESCUE DISC CREATOR

With the USB hard drive still plugged in, click "Start" and select "Reflect" to launch the program. Open the "Other tasks" menu and select "Create rescue media." The Windows PE option should be selected, so click "Advanced" and choose the "4.0" option if your non-booting PC came with Windows 8 installed. Otherwise, select "3.1" and click "OK," followed by "Next" to continue [**Image B**].

» The PE Architecture is one of the most important choices you have to make. Usually, the default setting (typically "64-bit" on newer PCs) is the right one to pick, but if your non-booting PC is running Windows XP, select "32-bit" instead. Ignore the Architecture Conflict warning that pops up by clicking "Continue." Then leave "Default base WIM (recommended)" selected and click "Next" [**Image C**].



Both Linux and Windows PE will recover all Windows operating systems.

● Windows PE 3.1 - Select this option to create Windows PE based recovery media.
The Windows PE environment provides all Macrium Reflect image, restore and cloning functionality. It also supports a wider range of PC hardware than Linux.

○ Linux - Select this option to create a Linux based recovery media.
Linux provides a compact and efficient rescue environment to restore all Windows operating systems.

Note: This option enables you to restore your imaged partitions to exactly the same size and postion as they were at the time the image was created.

If you require greater flexibility then choose the Windows PE opti

Please press the

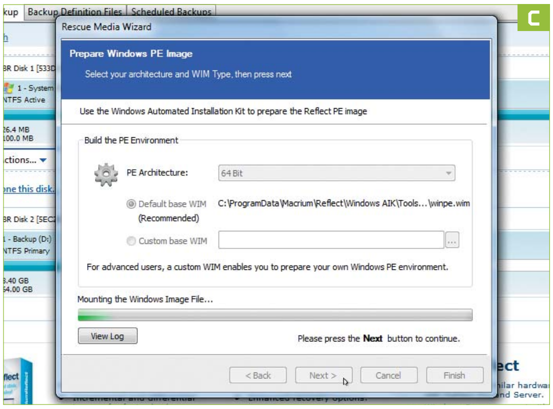
Rescue Media Wizard - Advanced

Windows PE version:
● Windows PE 3.1 rescue media
○ Windows PE 4.0 rescue media
○ Windows PE 5.0 rescue media

3 BUILD RESCUE FILES

Wait for the files to be collated, then click "Continue." You may receive two warning messages—one that says "Check your rescue media can access your drives," and one telling you about an update that requires upgrading. Click "Continue" to ignore them. If you're returned to the PE Architecture screen from here, just click "Next" to repeat the step.

» You should now be prompted to burn your rescue media—either CD/DVD (insert your disc) or USB. If you're using a USB flash drive, make sure you tick "Enable multiboot MBR/UEFI USB support" if you're trying to recover data from a newer PC with Windows 8 pre-installed. Click "Finish" to create the rescue media, then eject the disc or safely remove the flash drive.



Rescue Media Wizard

Prepare Windows PE Image

Select your architecture and WIM Type, then press next

Use the Windows Automated Installation Kit to prepare the Reflect PE image

Build the PE Environment

PE Architecture: 64 Bit

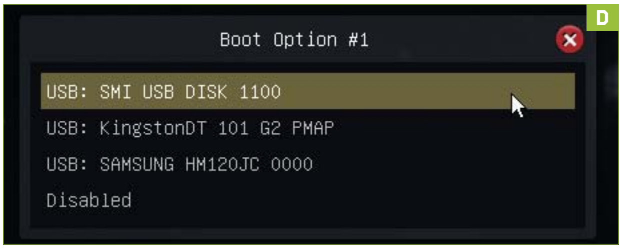
● Default base WIM (Recommended) C:\ProgramData\Macrium\Reflect\Windows AIK\Tools...\winpe.wim

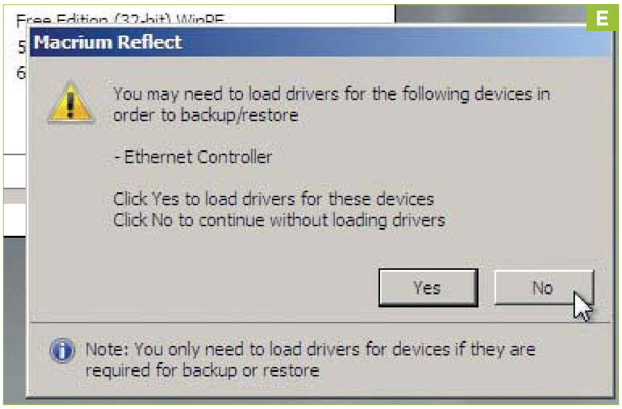
○ Custom base WIM

For advanced users, a custom WIM enables you to prepare your own Windows PE environment.

Mounting the Windows Image File...

Please press the **Next** button to continue.


D
Boot Option #1
USB: SMI USB DISK 1100
USB: KingstonDT 101 G2 PMAP
USB: SAMSUNG HM120JC 0000
Disabled


E
Free Edition (32-bit) WinPE
Macrium Reflect
Yes
No

You may need to load drivers for the following devices in order to backup/restore

- Ethernet Controller

Click Yes to load drivers for these devices
Click No to continue without loading drivers

Note: You only need to load drivers for devices if they are required for backup or restore

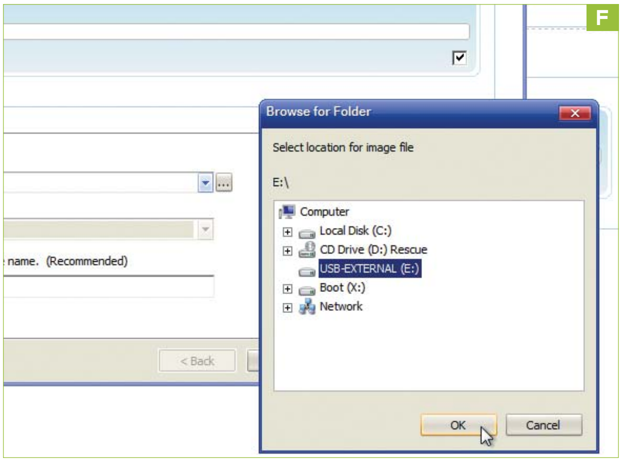
4 START THE NON-BOOTING PC

Next, plug the external hard drive into your non-functioning PC and power it up with the newly made rescue disc or USB flash drive inserted. If prompted, press any key to boot from CD or DVD. If no media is detected, restart your computer and look for an option to select the boot media in your BIOS. Choose your CD/DVD drive or USB flash drive from the list [**Image D**].

›› After a short pause, the Macrium Rescue Environment should start. If you're prompted to load drivers—typically network ones—you can click "No" [**Image E**]. You don't need them to detect your external hard drive. When the main screen appears, switch to the "Disk Image" tab. You should see both your internal, non-booting hard drive and the external drive you plan to recover data to.

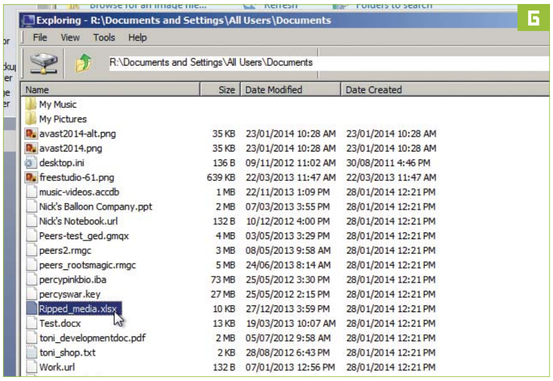
5 CREATE YOUR DRIVE IMAGE

The annotated screenshot on page 64 ("Create Rescue Media Now!") shows an option for backing up your hard drive, known as drive imaging [**Image F**]. This includes creating a forensic image in case you need to recover previously deleted data from your inaccessible drive, and choosing a more easily identifiable name for the drive image itself. Work your way through the wizard, then click "Finish."


F
☑
name. (Recommended)
< Back
Browse for Folder
Computer
Local Disk (C:)
CD Drive (D:) Rescue
USB-EXTERNAL (E:)
Boot (X:)
Network
OK
Cancel

Select location for image file

E:\


G
Browse for an image file...
Refresh
Folders to search
File
View
Tools
Help

Exploring - R:\Documents and Settings\All Users\Documents

R:\Documents and Settings\All Users\Documents

Name	Size	Date Modified	Date Created
My Music			
My Pictures			
avast2014-alt.png	35 KB	23/01/2014 10:28 AM	23/01/2014 10:28 AM
avast2014.png	35 KB	23/01/2014 10:28 AM	23/01/2014 10:28 AM
desktop.ini	136 B	09/11/2012 11:02 AM	30/08/2011 4:46 PM
freestudio-61.png	639 KB	22/03/2013 11:47 AM	22/03/2013 11:47 AM
music-videos.accdb	1 MB	22/11/2013 1:09 PM	28/01/2014 12:21 PM
Nick's Balloon Company.ppt	2 MB	07/03/2013 3:55 PM	28/01/2014 12:21 PM
Nick's Notebook.url	132 B	10/12/2012 4:00 PM	28/01/2014 12:21 PM
Peers-test_ged.gmqx	4 MB	03/05/2013 3:29 PM	28/01/2014 12:21 PM
peers2.rmgc	3 MB	08/05/2013 9:58 AM	28/01/2014 12:21 PM
peers_rootsmagic.rmgc	5 MB	24/06/2013 8:14 AM	28/01/2014 12:21 PM
percypinkbio.iba	73 MB	25/05/2012 3:30 PM	28/01/2014 12:21 PM
percyswar.key	27 MB	25/05/2012 2:15 PM	28/01/2014 12:21 PM
Ripped_media.xlsx	10 KB	27/12/2013 3:59 PM	28/01/2014 12:21 PM
Test.docx	13 KB	19/03/2013 10:07 AM	28/01/2014 12:21 PM
toni_developmentdoc.pdf	2 MB	05/07/2012 9:58 AM	28/01/2014 12:21 PM
toni_shop.txt	2 KB	28/08/2012 6:43 PM	28/01/2014 12:21 PM
Work.url	132 B	07/01/2013 12:56 PM	28/01/2014 12:21 PM

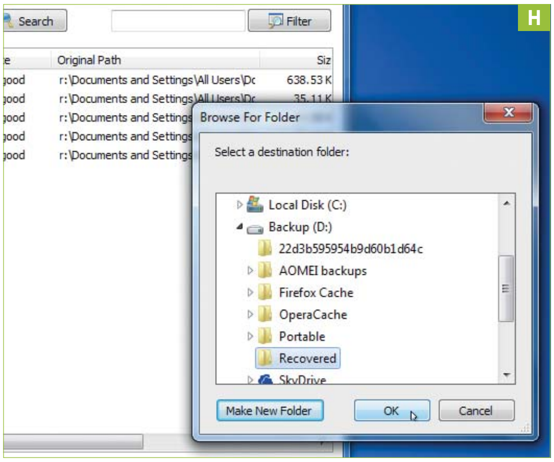
›› When the process is complete, click "OK" followed by "Close." Switch back to the "Restore" tab, where the drive image should now be displayed. Make sure the image isn't corrupt by clicking "Verify image." Click "Verify" and wait a moment for Macrium to check the image and confirm that it's intact. When this has been successfully verified, click "OK," followed by "Close."

›› Now switch back to the "Restore" tab. Under "Restore tasks," click "Open an image or backup file in Windows Explorer." If the image isn't displayed, select "Browse for folder" from the drop-down menu and click your USB hard drive. Once it's detected, tick the drive, assign it a letter from the drop-down menu, and tick "Enable access to restricted folders," before clicking "OK."

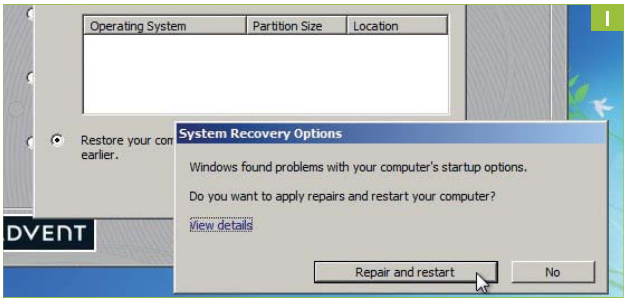
6 LOCATE AND COPY YOUR FILES

A new Explorer window will open, which should reveal all the files and folders on your non-bootable PC's hard drive [**Image G**]. You're now free to browse through the drive's contents for your lost folders and files, as if you were using the computer itself. Look under Users or Documents and Settings for your user folder—most of your personal files will be located here.

›› You've found the files you want to restore, but you can't open them directly from the rescue media, so close Macrium and shut down your PC. Boot the working PC again and plug the USB hard drive back into it. Locate and double-click your drive image to access it in the same way as you did in Step 5. This time you can also view and copy files from the image.


H
Search
Filter
Original Path
Siz
good
r:\Documents and Settings\All Users\Dc
638.53 K
good
r:\Documents and Settings\All Users\Dc
35.11 K
good
r:\Documents and Settings
good
r:\Documents and Settings
good
r:\Documents and Settings
Browse For Folder
Local Disk (C:)
Backup (D:)
22d3b595954b9d60b1d64c
AOMEI backups
Firefox Cache
OperaCache
Portable
Recovered
SkyDrive
Make New Folder
OK
Cancel

Select a destination folder:


I
Operating System
Partition Size
Location
Restore your computer ... earlier.
DVENT
View details
Repair and restart
No

System Recovery Options

Windows found problems with your computer's startup options.

Do you want to apply repairs and restart your computer?

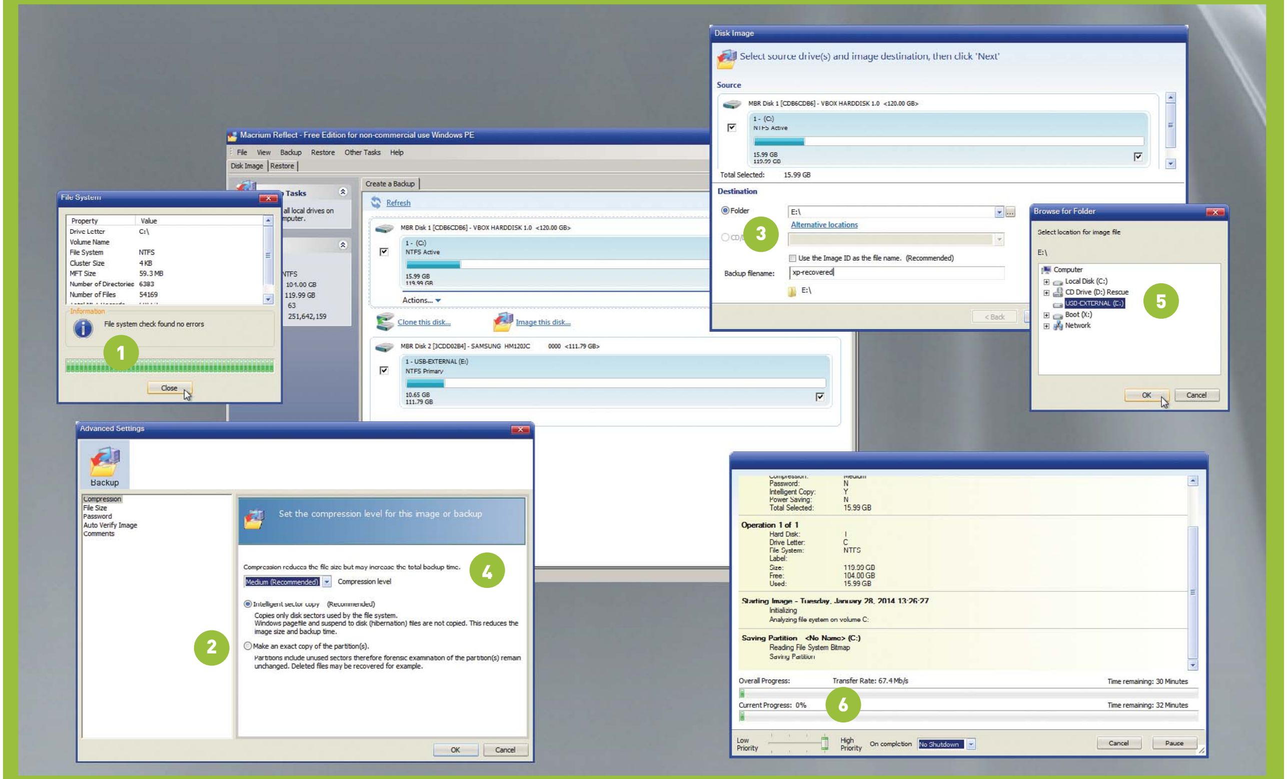
7 RECOVER, REPAIR, AND RESTORE

If you took a forensic image of the drive, it will contain all previously deleted data, as well as your existing files and folders. Armed with the right free tool—such as Glary Undelete (from www.glarysoft.com)—you can search for and attempt to recover deleted files [**Image H**]. Once the tool is installed, just select your mounted drive image and click "Scan" to see what it can find.

» With your data now accessible from your drive image, you can go back to trying to fix your non-booting PC, secure in the knowledge that whatever happens, you won't lose all your data. Try booting from your Windows installation disc or recovery media and look for repair options to see if the problem can be fixed for you [**Image I**]. If it can, you won't need to perform any further data recovery.

» Congratulations! Even if you're forced to reinstall or recover Windows from scratch, you can now do so without losing any of your files. Once the reinstall and post-reinstall processes are complete, install Macrium Reflect Free on your PC, then plug in your USB hard drive, and mount your drive image to copy your files back to the internal hard drive.

CREATE RESCUE MEDIA NOW!


1
2
3
4
5
6
File System
File system check found no errors
Close
Macrium Reflect - Free Edition for non-commercial use Windows PE
Advanced Settings
Set the compression level for this image or backup
Disk Image
Select source drive(s) and image destination, then click 'Next'
Browse for Folder
Select location for image file
OK
Cancel
Pause

1. CHECK DRIVE

You can quickly see if your PC's drive is in good working order before backing it up. Click "Actions" under the drive and choose "Analyze file system."

2. FORENSIC IMAGES

Pick the "Forensic" option to take an exact copy of the entire drive for advanced data recovery purposes. Note, however, that standard images are smaller and quicker to create.

3. NAME YOUR IMAGE

The entire contents of your recovered drive are stored in one file, called a drive image. Untick this box to give it a more easily identifiable name.

4. REDUCE IMAGE SIZE

After clicking "Next" to view the summary screen, click the "Advanced Options" button for more options. Start by reviewing the compression options—if space is tight, set this to "High."

5. SELECT YOUR BACKUP DRIVE

After clicking "Image this disk," click the "..." button to select your external USB drive or a folder on it as the place to store your backup.

6. GET BACKED UP

Once you're ready, close Advanced Options and click the "Finish" button. Macrium will now back up your non-booting drive's contents to your external hard drive.

Customize Your Windows 10 Start Menu

YOU'LL NEED THIS

WINDOWS 10
The new Microsoft OS is officially released on 29 July. Get your free upgrade from www.microsoft.com.

WITH WINDOWS 10 ARRIVING THE DAY AFTER THIS ISSUE GOES ON SALE, you might be wondering what exciting changes will be in store, and if they'll be easy to get your head around. Well, in short, we can guarantee that you'll be up and running with your new operating system in next to no time. Of course, there's plenty that's different. But that's no bad thing. Fear not, Windows 10 is designed to make your computing life more streamlined than ever before. In this tutorial we'll look at the Start menu, and see what's changed with the launch of Windows 10. So, let's get started! –**ZAK STOREY**

1 PIN AN APP TO THE START MENU

We'll begin by adding programs to the new Start menu. If you're familiar with how to do this in Windows 7, it follows exactly the same routine here. Find the app you wish to add, right-click it, and select "Pin to Start."

2 ON THE TILES

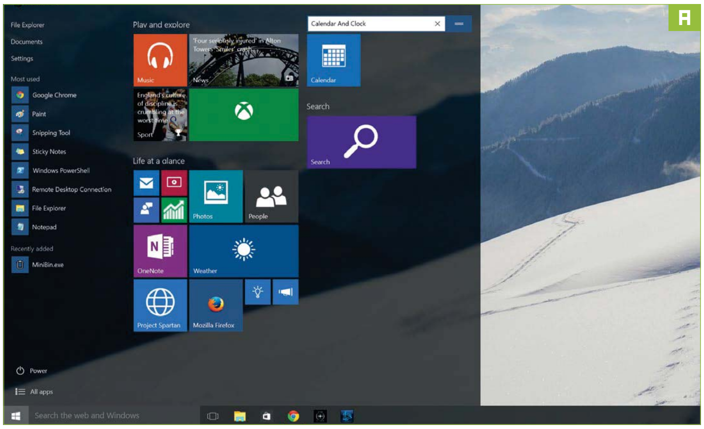
We now have the app's icon pinned to the Start menu as a tile. You can customize your Start menu by resizing and moving the tiles around. Simply right-click on one to bring up a drop-down menu. Here you can switch live tiles off or on, resize them, and much more.

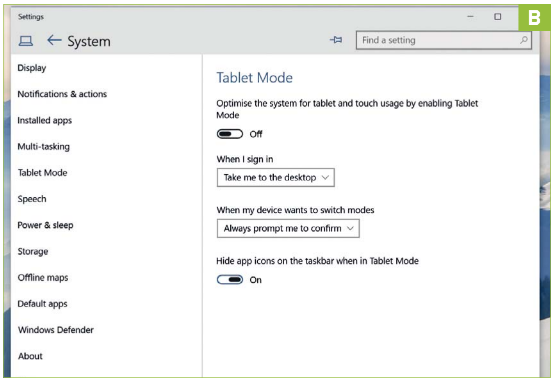
3 RESIZING PINNED APPS

Next, we'll resize a tile to make it smaller. Apps downloaded from the Windows Store offer more options when it comes to resizing, while other programs only have the option to go from medium to small (and vice versa). You can now drag the tiles into the order that suits you best.

4 GROUP AND TITLE

You can also arrange tiles into groups. The groups can be renamed into categories, which can be useful. To do this, move your cursor just above each column group and left-click once. You can now type in a name for the group [**Image A**].


A
File Explorer
Documents
Settings
Most used
Google Chrome
Paint
Snipping Tool
Sticky Notes
Windows PowerShell
Remote Desktop Connection
File Explorer
Notepad
Recently added
MiniBin.exe
Power
All apps
Search the web and Windows
Play and explore
Music
'Four seriously injured' in Alton Towers 'Smiler' crash
News
England's culture of discipline is crumbling at the worst time
Sport
Calendar And Clock
Calendar
Search
Search
Life at a glance
Photos
People
OneNote
Weather
Project Spartan
Mozilla Firefox


B
Settings
System
Find a setting
Display
Notifications & actions
Installed apps
Multi-tasking
Tablet Mode
Speech
Power & sleep
Storage
Offline maps
Default apps
Windows Defender
About

Tablet Mode

Optimise the system for tablet and touch usage by enabling Tablet Mode

Off

When I sign in

Take me to the desktop

When my device wants to switch modes

Always prompt me to confirm

Hide app icons on the taskbar when in Tablet Mode

On

5 ALL APPS

With Windows 10's Start menu comes a slight change in the way you access programs (which is similar to Windows 7)—the All Apps tab at the bottom of the Start menu brings up a list of everything installed on your computer for quick and easy access.

6 RESIZE THE ENTIRE MENU

If you feel the Start menu is still a little too big, you can resize the entire thing. As you would with a window, move the mouse to the edge of the Start menu and left-click. You can now hold to drag and resize the Start menu to the size you want.

7 CLASSIC WINDOWS 8 MODE

If you really don't want to leave Windows 8 and miss the Tile menu, Microsoft has it covered. Simply click the diagonal arrow in the top right-hand corner of the Start menu. From now on, this will expand the Start menu across the entire screen.

8 ENABLING TABLET MODE

If you have a two-in-one tablet, the more desktop-like interface may not be right for you. If you want to change back to a style more akin to Windows 8, click "Settings" from the Start menu, then go to "System," and switch on "Tablet Mode" [**Image B**].

Set Up A Homebrew Security System

YOU'LL NEED THIS

USB CAMERAS
A bunch of cheap, off-the-shelf cameras that connect via USB.

ISPYCONNECT
Download the free software from www.ispyconnect.com.

VLC MEDIA PLAYER
The iSpyConnect app requires this player for playback of captured video.

HOW MANY PEOPLE do you know who own security cameras? Despite all of us having things of value all around the house, which we'd like to keep an eye on (such as vehicles, laptops, smartphones, babies...), not many of us actually invest in comprehensive security solutions. The freely available iSpyConnect software lets you string multiple webcams into a fully featured closed-circuit television monitoring setup. The software can work with any webcam that Windows can detect, and turns them into advanced motion-detecting devices with which you can monitor all corners of your house.

In addition to its ability to add and monitor any number of cameras, the software's motion-detection abilities are one of its strongest suits. iSpyConnect ships with multiple strategies for detecting motion, each suited for a different situation, from tracking the movements of your newborn in the crib, to the Camaro in the garage. The freely available features are complemented with optional features that require you to pay for a subscription. The extra services include sending you text alerts or letting you access your monitoring station from a mobile device. –MAYANK SHARMA

1 GETTING STARTED

Download iSpyConnect from www.ispyconnect.com and install it. For best performance, ensure that you download the recommended version for your architecture. Also head to "Shop → Subscribe" and create a free iSpy Connect account, which you can use to monitor your CCTV on any computer on the same network, for free. When you launch the app, you're greeted with a fairly sparse looking dashboard that'll take on another look as you flesh out the monitoring setup and add multiple cameras.

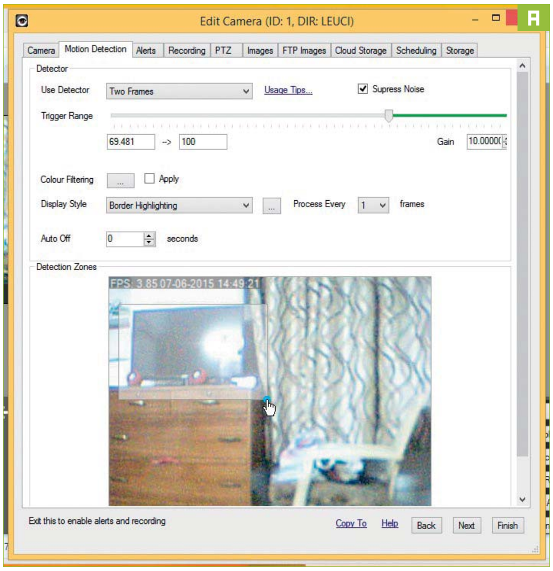
›› To get started, click the "Add" button in the main toolbar on the dashboard. This will bring up a list of the types of cameras and devices supported by iSpy. Select the "Local Camera" option to add a camera available locally, such as an integrated camera or one connected via USB. This will bring up the the Video Source window. Use the Video Device pull-down menu to select one of the available cameras. You can also select a different recording resolution from the conservative default, using the Video Resolution pull-down menu.

›› Remember, however, that higher resolutions require more processing power. For example, the processing power required to record one 1280x960 camera can instead be used to record four cameras at 640x480 or 16 cameras at the default 320x240. Choose the resolution carefully, depending on the number of cameras in your setup and your requirements.

2 CONFIGURE MOTION DETECTION

After adding a camera, you're automatically taken to the Edit Camera window. You can use the multiple tabs in this window to define all aspects of the camera. Use the Name field in the Camera tab to uniquely identify it from the pool of cameras. Instead of recording videos indiscriminately, you can tweak the security cameras that are used for keeping an eye on an inanimate object or a usually passive scene to only record video when things are happening. Switch to the Motion Detection tab [Image A] to configure the camera for this purpose.

›› Start by selecting one of the motion detection schemes from the Use Detector menu. The default is the Two Frames scheme, which detects motion after comparing the last frame with the current one. Alternatively, you can use Custom Frame, which compares the current frame with one stored in memory. This is useful for detecting removed objects. There's also the Background modeling scheme, which also takes a custom frame, but adapts it to the current frame to ignore constant movements.



Use Detector: Two Frames
☑ Supress Noise
Trigger Range: 69.481 -> 100
Gain: 10.0000(
Colour Filtering: ... ☐ Apply
Display Style: Border Highlighting
Process Every: 1 frames
Auto Off: 0 seconds
FPS: 3.85 07-06-2015 14:49:21
Exit this to enable alerts and recording

›› Next, select one of the motion-detection schemes and then draw rectangles on the preview area to add monitored sections. On the live preview, you'll see a blue bar and a green line, which show the detection and trigger levels. Use the Trigger Range slider to adjust the sensitivity required to detect motion. At the highest sensitivity level, even the slightest movement will cause the motion detection to activate. A level of between 50 and 75 works best for most scenes, but you'll have to spend some time to fine-tune this as per your setup.

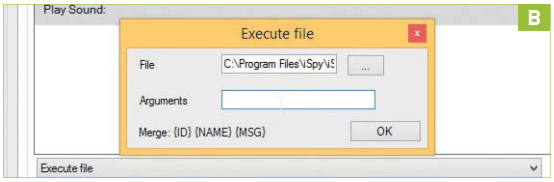
›› Use the Display Style pull-down menu to select a style for highlighting detected movement. The Object Tracking style lets you track movement based on the number of objects in the scene.

3 DEFINE ALERTS

To define what your setup will actually do when motion is detected, switch to the Alert tab [Image B]. The section is divided into two broad areas. You have to define-select a trigger mode and an action. Use the Mode pull-down to choose a trigger. You can trigger an alert based on motion, number of objects, and lack of movement.

» You can add more trigger modes, such as Face Detection, by installing freely available plugins using the Plugins link. We'll use the Movement trigger for this tutorial. Also, by default, iSpy will trigger an alert after three minutes. Use the Intervals button and change the Distinct Alert Interval setting to a lower time value to trigger alerts sooner, especially during testing.

» After selecting a trigger mode, you need to tell iSpy what action to perform. Use the Select Action pull-down menu to choose from one of the predefined actions. When you select an action, click the "Add" button to customize any related options. For example, if you select the Play Sound action, you'll be asked to point to an audio file when you click the "Add" button. iSpy can also send you an email, an SMS, and a tweet when it detects motion, but these actions require a paid subscription. You can add multiple actions and iSpy will execute them all. So we'll scare away any potential thieves by adding a Beep action, a Play Sound action, as well as the Show Window action, to show them that they are being recorded.


B
Play Sound:
Execute file
×
...
OK
Execute file

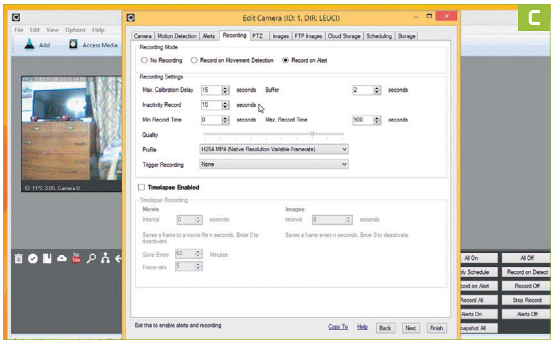
File: C:\Program Files\iSpy\iS

Arguments:

Merge: {ID} {NAME} {MSG}

4 CHOOSE A RECORDING MODE

To record video, switch to the Recording tab [Image C] and toggle one of the three radio buttons to select a recording mode. The No Recording mode asks iSpy to only record video when it's triggered manually or as per a schedule. The Record on Movement Detection option starts recording video as soon as motion is detected, ignoring time settings defined in the Alert section. The option we'll be using is Record on Alert, which records video only when an alert is generated. It also respects the time intervals setting in the Alerts tab, which prevents the app from generating multiple alerts for a single event. Furthermore, this option also comes in handy when you've set the freely available Face Recognition plugin in the Alerts section, or the paid Number Plate recognition plugin as a trigger mode.


C
Edit Camera (ID: 1, DIR: LEUCI)
Camera
Motion Detection
Alerts
Recording
PTZ
Images
FTP Images
Cloud Storage
Scheduling
Storage
Add
Access Media
Copy To
Help
Back
Next
Finish
All On
All Off
Record on Detect
Record on Alert
Record Off
Record All
Stop Record
Alerts On
Alerts Off

Recording Mode: ○ No Recording ○ Record on Movement Detection ● Record on Alert

Recording Settings

Max. Calibration Delay 15 seconds Buffer 2 seconds

Inactivity Record 10 seconds

Min Record Time 0 seconds Max. Record Time 900 seconds

Profile: H264 MP4 (Native Resolution Variable Framerate)

Trigger Recording: None

☐ Timelapse Enabled

Timelapse Recording

Movie: Interval 0 seconds. Saves a frame to a movie file n seconds. Enter 0 to deactivate.

Images: Interval 0 seconds. Saves a frame every n seconds. Enter 0 to deactivate.

Save Every 60 Minutes

Frame rate 5

Exit this to enable alerts and recording

» You can optionally tweak the settings under the Recording Settings section, though the defaults should work for most users. The Max Calibration Delay setting gives the camera time to adjust to the ambience of the room it is monitoring. Increase this value if you're getting erroneous triggers from your camera.

» One setting you can customize is the Inactivity Record setting, which determines how long the camera continues recording once movement stops. The Profile setting drop-down houses various profiles for encoding the recording. We'll stick with the default H264 MP4 profile.

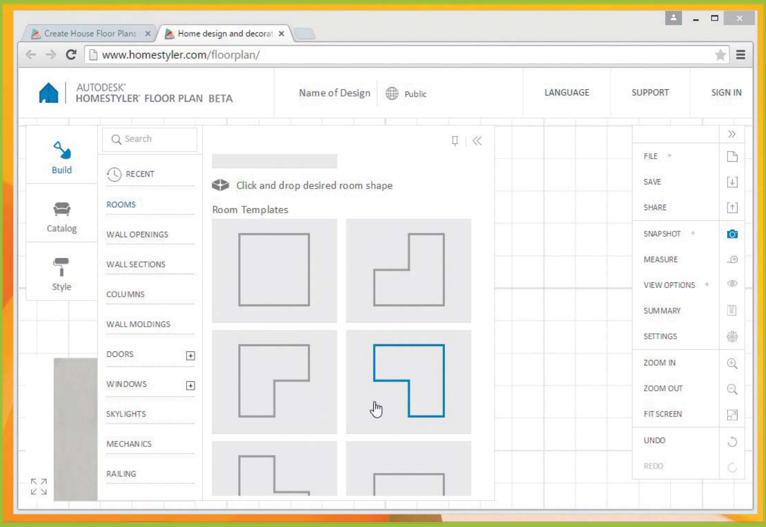
» If you're using multiple cameras to monitor the same scene from different angles, you can ask the other camera to also start recording when one detects motion by selecting it from the Trigger Recording pull-down menu.

CREATE A FLOOR PLAN

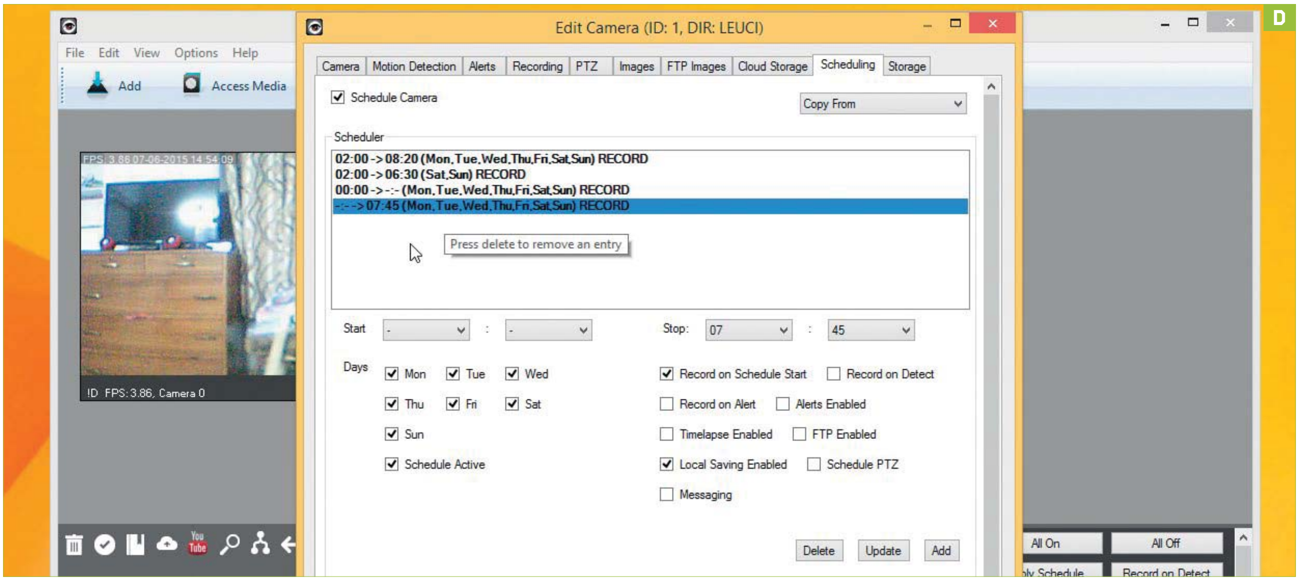
To better monitor your house, you can add a floor plan to iSpy. Once you've added all of your cameras, you can then place them on top of the floor plan to get a better hang of the activities transpiring in your home.

Make sure you've added all of your cameras first, then head to "Add → Floor Plan," and click the "Image" button to point it to the image file of your floor plan. Once you've added a floor plan, drag and drop the added cameras from the list below the image on to the floor plan. Hold down Shift while dragging the mouse pointer to rotate the camera and point it to another part of the room. To change its angle of view, hold down Alt.

The cameras are color-coded to reflect their activity. Green cameras are active, black are disabled, and red ones are recording. Click on a camera to bring it up and monitor its activity. Repeat the process until you've added all of your cameras to the floor plan.


Create House Floor Plans
Home design and decorat
www.homestyler.com/floorplan/
AUTODESK
HOMESTYLER FLOOR PLAN BETA
Name of Design
Public
LANGUAGE
SUPPORT
SIGN IN
Build
Catalog
Style
Search
RECENT
ROOMS
WALL OPENINGS
WALL SECTIONS
COLUMNS
WALL MOLDINGS
DOORS
WINDOWS
SKYLIGHTS
MECHANICS
RAILING
Click and drop desired room shape
Room Templates
FILE
SAVE
SHARE
SNAPSHOT
MEASURE
VIEW OPTIONS
SUMMARY
SETTINGS
ZOOM IN
ZOOM OUT
FIT SCREEN
UNDO
REDO

Create a plan with a free tool, like Autodesk Homestyler (http://bit.ly/1rvbwB9).


D
File Edit View Options Help
Add
Access Media
FPS: 3.86 07-06-2015 14:54:09
ID FPS: 3.86, Camera 0
All On
All Off
Record on Detect

Edit Camera (ID: 1, DIR: LEUCI)

Camera | Motion Detection | Alerts | Recording | PTZ | Images | FTP Images | Cloud Storage | Scheduling | Storage
Copy From
Delete
Update
Add

☑ Schedule Camera

Scheduler

```
02:00 -> 08:20 (Mon,Tue,Wed,Thu,Fri,Sat,Sun) RECORD
02:00 -> 06:30 (Sat,Sun) RECORD
00:00 -> -:- (Mon,Tue,Wed,Thu,Fri,Sat,Sun) RECORD
-:- -> 07:45 (Mon,Tue,Wed,Thu,Fri,Sat,Sun) RECORD
```

Press delete to remove an entry

Start - : -   Stop: 07 : 45

Days ☑ Mon ☑ Tue ☑ Wed ☑ Thu ☑ Fri ☑ Sat ☑ Sun

☑ Schedule Active

☑ Record on Schedule Start ☐ Record on Detect
☐ Record on Alert ☐ Alerts Enabled
☐ Timelapse Enabled ☐ FTP Enabled
☑ Local Saving Enabled ☐ Schedule PTZ
☐ Messaging

5 ADDITIONAL SETTINGS

You're now ready to put the webcam into action, but there are a couple more settings you should browse through. In addition to video, if you wish to take snapshots from the video feed, you can set it up in the Images tab. Toggle the Local Saving Enabled checkbox and then review the format for naming the captured images. iSpy can capture images either on detecting motion, or when an alert is triggered, or after defined intervals. Select the option that suits you. You can also change the quality of the image, and customize the Overlay text.

» Depending on your setup, you might be generating a lot of video and images. To keep them in a directory with adequate space, switch to the Storage tab and alter the Media Location field to point to somewhere with plenty of space. Also, toggle the Storage Management option and specify a maximum size a folder can grow to, as well as the maximum number of hours that footage can be stored for, after which iSpy will automatically zap them.

» In addition to recording video on detecting motion, you can also schedule a camera to record at certain times from under the Scheduling tab [Image D]. Use the pull-down menus under the Start and Stop sections to schedule recording.

6 MONITOR YOUR REALM

Once you've added all of your webcams, they'll appear in iSpy's Dashboard and you can move them around, resize them, and right-click on them to edit their settings. The right-click menu houses interesting options. The Take Photo option takes a snapshot of the current frame of the camera, while the View media option lets you view the camera on the iSpy website using the iSpy account we created in the first step.

» To back up your setup, head to "File → Save Object List" to save the current configuration, including the camera setups and configurations, in an XML file that you can load into iSpy.

» All recorded footage appears in the media panel at the bottom. Since it can get pretty crowded, you can filter the media, based on the cameras and dates, by clicking the magnifying glass icon in the tool strip. Click a video to play it using the integrated player, which also has the option to save the video to a custom location. You can merge all recordings from a particular camera by using the icon next to the magnifying glass in the tool strip.

» Since we've registered for an iSpyConnect account, we can monitor our CCTV setup from other computers and devices on the local network. Head to the iSpyConnect website and click the "Login" button to sign in with the credentials created in the first step. Your CCTV setup will be listed under the Connected Servers section and you can click it to monitor and control the cameras. If you like this feature, consider subscribing to the premium service, which extends this ability over the Internet.

ADD ADDITIONAL DEVICES

You can also add microphones to your setup. Head to "Add → Microphone," then follow the wizard to either add a dedicated mic or the one connected to your webcam, set its sensitivity, create alerts, and set recording options.

iSpy also ships with a server component that you can install on remote computers and use to access any connected cameras. Copy the iSpy Server installer to the remote machine and install it. When prompted, allow Windows Firewall to add an exception for the iSpy Server. Launch the server app and add the camera, just like you do in iSpy. The only difference is that the cameras on the remote machine display an IP address, Port, and Cam ID.

Return to the main iSpy PC and go to "Add → IP Camera." In the MJPEG URL field, enter the camera details like this: http://[IPAddress]:[Port]/?camid=[CamID]. You can also turn any Android device into an IP camera with the freely available IP Webam app on Google PlayStore. Install the app on your phone and tap "Start server." This will start the video feed and display a URL at the bottom. Now head to iSpy and add an IP camera. In the MJPEG URL field, enter the IP address shown at the bottom of the feed in the IP webcam app in this form: http://[IPAddress]:[Port]/videofeed.

Improve Productivity on Windows 10

YOU'LL NEED THIS

WINDOWS 10
Microsoft's latest operating system is available as a free upgrade for Windows 7 and Windows 8/8.1 users.

WINDOWS 10 BRINGS A LOT OF NEW FEATURES to the table. It also reworks a lot of the old ones to the state that they should've been in at the launch of Windows 8. Old favorites such as AeroSnapping have been expanded, allowing you to organize your workspace a little easier, and finally we have the fabled "Task View" button, allowing us to see all open applications at once—something that Apple users have enjoyed for years. There's also command prompt now having copy and paste, and, of course, the hallowed DirectX 12 making its debut. But what other interesting tidbits has Microsoft given us to make our lives that little bit better? **–ZAK STOREY**

1 SWITCH TO TABLET MODE

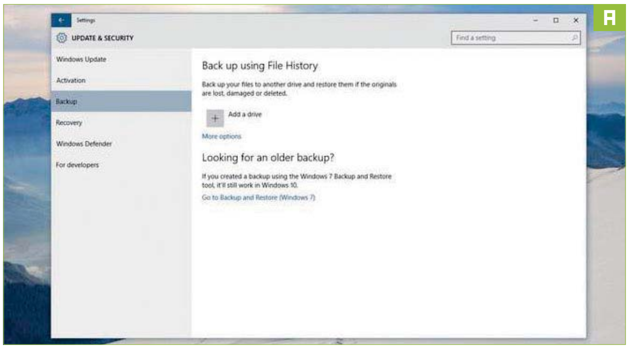
Windows 10 introduces a tablet mode, enabling touch office and a UI reminiscent of Windows 8. This should be activated by default during install on tablets, but for two-in-one laptops, you may need to jump between the two on the fly. To do this, open the Start menu and select "Settings," then "System." Here you'll find the vast majority of your options for display, storage, and power features, as well as the "Tablet Mode" section. You can enable Tablet Mode and tell Windows how you want it to behave on sign in and mode switching.

2 AEROSNAPPING

Snapping programs to the sides of the screen was a feature introduced in Windows 7. In Windows 10, you can now snap applications to each corner, as well as to the sides, by left-clicking and dragging the top bar into a corner. You'll also see a visual representation of how much screen space the application will take up. This makes it much easier to multi-task from multiple documents at any given time, especially now that 27-inch monitors, and bigger, are becoming more common.

3 CREATING A SECURE BACKUP

You'll need at least 120GB of excess storage on a separate partition to create a secure backup. Go to "Settings" and select "Update & Security," then click "Backup" and hit "+" to select the partition or drive you wish to use [**Image A**]. Once done, select "more options," then "See advanced settings." Now click "System Image Backup," followed by "Set up Backup." Highlight the drive you want to use and click "Next," then "Let Windows Choose." Hit "Next" again. Finally, press "Save settings and run backup."

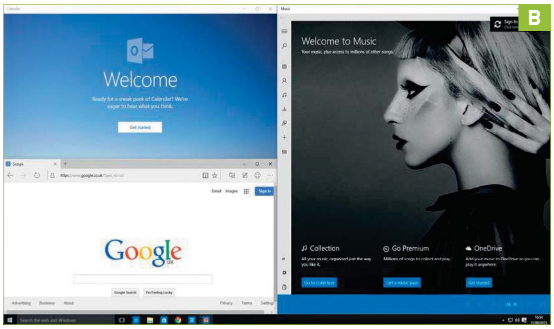


Back up using File History

Back up your files to another drive and restore them if the originals are lost, damaged or deleted.

Looking for an older backup?

If you created a backup using the Windows 7 Backup and Restore tool, it'll still work in Windows 10.



Ready for a sneak peek of Calendar? We're eager to hear what you think.

Your music, plus access to millions of other songs.

All your music, organised just the way you like it.

Millions of songs to collect and play.

Add your music to OneDrive so you can play it anywhere.

4 CORTANA ON CALL

When signed into your Microsoft account, you can use Cortana for all sorts of things, from searching the Internet for answers, to setting calendar reminders or even sending emails. To get going, all you have to do is say "Hey Cortana" (making sure your mic or webcam is enabled), or type Cortana into the search bar at the bottom left-hand corner of your screen. To do this, you'll need to sign into your Microsoft account [**Image B**].

5 ORGANIZE MAIL ACCOUNTS INTO ONE

Mail has received a fresh new look as well, and keeping your emails all in one place is now considerably easier than it was previously. Click the "Mail" icon in your Start window, select "Add account," choose your email service, and fill in the details. You can do this multiple times to increase the amount of email addresses you can have synced to the application. Once finished, select "Done" and all your emails will be in one place.

6 UNINSTALLING THE OLD WINDOWS

So, are you positive that Windows 10 is your new home? Not bothered about going back? Well, you should probably remove those old operating systems clogging up your SSD. To uninstall the old bag of bones from your PC, click the Start menu, type "disk clean up," and open the "Disk Clean Up" application. Select which drive you have your previous editions installed on (most likely "C:"), press "OK," and let Windows scan the drive. Scroll down and tick the "Previous Windows Installation(s)" tab, select "Clean up system files," and you're done.

BUILD IT

JARRED WALTON **SENIOR EDITOR**

Virtually Prepared: Getting Ready For Oculus Rift

Welcome to the Wild West of VR

LENGTH OF TIME: **1–3 HOURS** LEVEL OF DIFFICULTY: **MEDIUM**

THE MISSION

VIRTUAL REALITY is a hot topic for PCs right now, and everyone wants a piece of the action. It's a Wild West free-for-all as different hardware and platforms are announced, so putting together a gaming rig that can handle the demands of the upcoming VR setups is a real concern. Oculus VR has recently helped clear the air by publishing the recommended specs for its Rift platform. Depending on your current system, the recommended hardware either looks moderately tame or outlandishly extravagant. The core components consist of the CPU, GPU, and RAM: Core i5-4590, GTX 970 or R9 290, and at least 8GB.

If you want to minimize on costs, you could easily build a complete Oculus-ready system for around $800, including the OS, but we view these recommendations as more of a minimum rather than a long-term solution. No one likes to be caught unprepared when the inevitable next round of updates shows up, so we set about building a rig that has some room for upgrades down the road. Our baseline rig meets the Oculus recommendations, and when Oculus 2.0 doubles down in a year or two, you'll be ready. Trusty screwdriver in hand, let's get busy building.

SADDLE UP

IN THEORY, all you need to get started with building a VR-capable rig is any computer case to house your components, but a poor choice can leave your rig pushing up daisies in short order. If you want to be going strong for several years, you'll need something more capable. We've opted for a larger case that offers plenty of room for expansion; we also chose a slightly faster processor, a motherboard that can support a second GPU, and included an SSD, which ought to be required for any new PC in 2015.

The case is Antec's shiny-new P380, an understated yet attractive design with plenty of room that doesn't make a lot of noise. Our graphics card is the diminutive Asus GTX 970 DirectCU Mini, packing a lot of power into a small package while using much less power than the AMD R9 290. The CPU is Intel's i7-4790K, cooled by the Cooler Master Hyper 212 EVO, though the i5-4690K could save you $100 without hurting gaming performance. ASRock's Z97 Extreme6 mobo is good value, and if you want wireless AC integrated into the board, check out its similarly priced Extreme6/ac. Either one makes adding a second GPU simple. Powering the system is the Corsair CX500, a compact but non-modular PSU. We used some generic DDR3-1600 memory, as RAM typically has little impact on real-world performance. Wrapping things up, we went with a 250GB Samsung 850 EVO SSD and a 2TB Hitachi HDD.

INGREDIENTS

PART		PRICE
Case	Antec P380	$180
PSU	Corsair CX500	$55
Mobo	ASRock Extreme6 Z97	$165
CPU	Intel Core i7-4790K	$340
Cooler	Cooler Master Hyper 212 Evo	$35
GPU	Asus GTX 970 DirectCU Mini OC	$345
RAM	2x 4GB DDR3-1600	$50
SSD	Samsung EVO 850 250GB	$100
HDD	Hitachi Ultrastar A7K2000 2TB	$60
OS	Windows 8.1 64-bit OEM	$100
Total		$1,430

1

TRUE GRIT

AS WE GO TO PRINT, Intel has just announced its desktop Broadwell parts, and they should be available by the time you read this. The good news is that the i5-5675C should work fine in the ASRock Z97 Extreme6 mobo we've selected; the bad news is that the Iris Pro 6200 graphics and reduced CPU clock speeds aren't really an upgrade for those using a discrete GPU.

Further out is Skylake, with leaks showing a Core i5-6600K for the new LGA 1151 platform. It ought to provide improved performance, but it will also require a new motherboard and memory. Bottom line: We have to build with parts that are currently shipping, so we stuck with Haswell. The past several generations of CPUs from Intel haven't radically altered CPU performance, and Broadwell doesn't change that, so the Core i7-4790K should keep you happily gaming for years to come.

2

YOUNG GUNS

IF YOU'RE NEW TO BUILDING PCs, it's often necessary to mount your cooler prior to installing the motherboard into the case. The P380 has a cutout on the back, so you could do it either way, but larger air coolers like the Hyper 212 Evo can be a bit finicky to install, so it's best taken care of first.

We could've also skipped the aftermarket cooling altogether, as we're running stock CPU clocks. There's nothing wrong with that approach, but the larger fan on the EVO makes less noise and will keep the CPU frosty. It's also not so large that it will interfere with the DIMMs, but the side-facing fan likewise isn't going to provide a lot of airflow to the RAM or mobo heatsinks.

3

HANG 'EM HIGH

THE P380 COMES WITH THREE FANS—two 140mm at the top and one 120mm at the back—each with a speed selector. All three fans come pre-installed near the top-left of the case, venting hot air. That means Antec is using negative pressure cooling by default, which often has the undesirable side effect of pulling dust in through every crack and seam over time. We didn't add any intake fans for this build, but there's room for a couple of 140mm (or three 120mm) fans on the front panel.

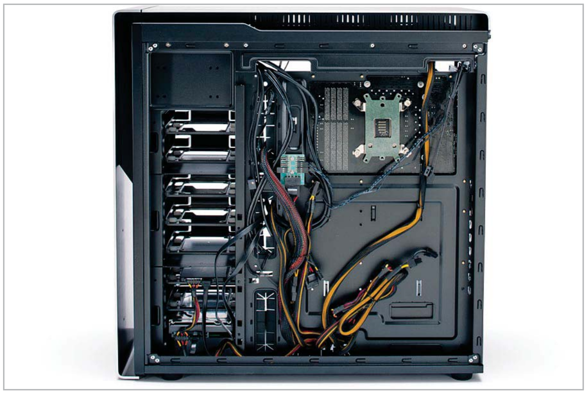
If you want to use liquid cooling, there's also room at the top and back for radiators. The P380 has an integrated fan power hub on the back, but it's there purely for providing power. It would have been nice if Antec had included external fan-speed switches, but cooling worked well enough even with all three fans set to low speed.

4

TAKE IT EASY

THERE ARE TWO MAIN PHILOSOPHIES when it comes to wiring your case. Some want a pristine-looking wiring job, and others just tuck everything out of the way and call it good. The drawback of cleaning up the wiring too much is that if you then need to add another component, you're often stuck undoing your earlier work and then tidying up again.

For frequent upgrades, it's easier to not spend too much effort on the "hidden" wires—it's not like anyone looks at the back of your motherboard. Also notice that the 8-pin EPS12V cable for the CPU has to reach quite far, and the 26-inch cable on the CX500 makes this easy. A PSU with a 22-inch CPU cable likely wouldn't be able to route behind the motherboard.



5

THE LONE RANGER

OUR SINGLE GTX 970 is so small in this cavernous case that it looks a bit lonely. Smaller cases might require that you remove one of the hard-drive cages to fit longer GPUs, but not the P380. If you want to add a second GPU, or even go with a couple of significantly larger GPUs, such as AMD's R9 295X2, there's room to spare. The case will also support E-ATX mobos, if you're looking to install something larger.

Oculus VR may only recommend a single R9 290 or GTX 970, but the other VR options may end up pushing the envelope further. If you're looking to add a second GPU in the future, however, we'd recommend stepping up to a 700W–800W modular PSU.

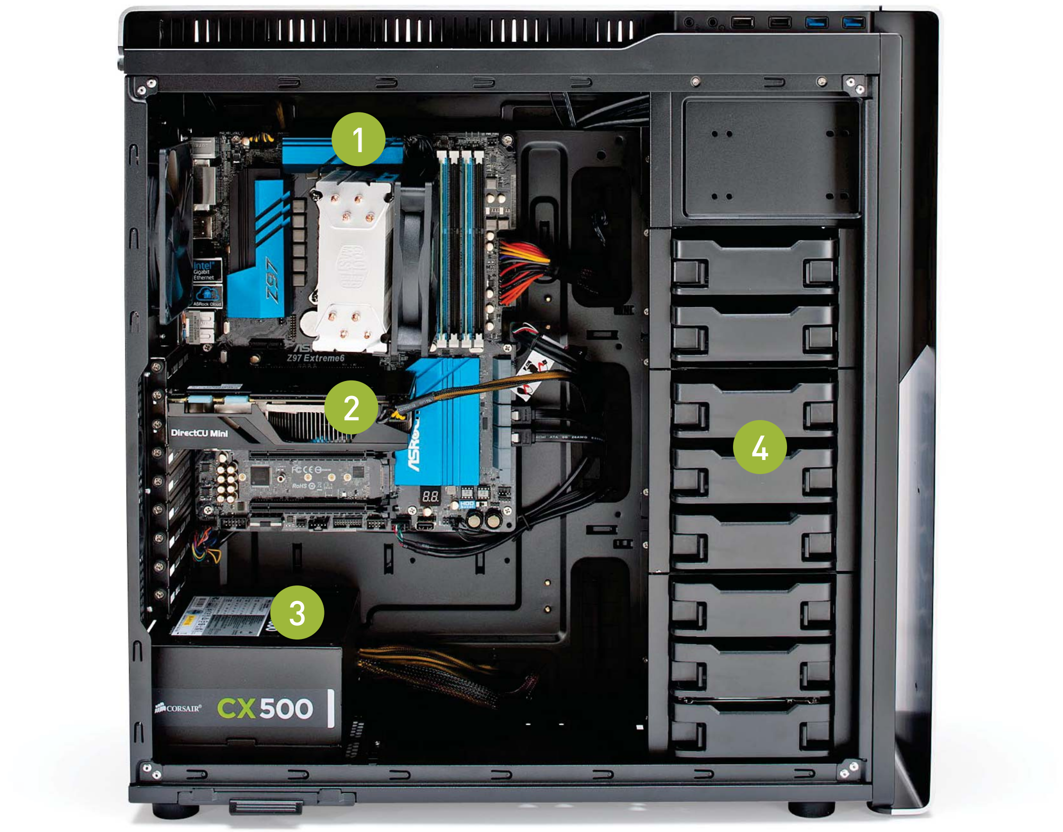
DirectCU Mini
ASUS
ASRock

6

FISTFUL OF DOLLARS

SAY WHAT YOU WILL for other aspects of the case, but the P380 is a real looker. Antec uses 4mm-thick aluminum front and back panels, giving the case a distinctive look, but also jacking up the price. We think the clean front fascia with no external drive bays looks awesome, but what if you still want an optical drive? Antec includes a slim optical drive mount that sits behind the front cover. It's frankly a bit of a pain to deal with, so if you really want an optical drive you might want to look at a different case.

It's possible to swap around the USB and audio ports on the top, allowing them to face right or left (the default is left). You can also remove all the front drive cages and mount a second 240mm radiator, if you're so inclined, but that limits storage options.



1 You can fit up to a 360mm radiator, but sometimes a simple air cooler is all you need.

2 The Asus GTX 970 uses a single 8-pin PCIe power cable, helping reduce connectors and clutter.

3 The tiny 500W Corsair PSU has long cables, a must for a case this large.

4 Eight 3.5/2.5-inch trays allow for ample storage, with two 5.25-inch slots up top (but with no external access).

HI-YO, SILVER!

FOR SOMETHING AS demanding as rendering two stereoscopic images for VR, the recommended specs from Oculus aren't actually that crazy. In fact, our midrange Blueprints going back as far as October 2014 have all been sufficient, and only the shift to Nvidia's Maxwell 2.0 architecture rules out older builds. That's simple enough to fix, of course, as swapping graphics cards is one of the easiest upgrades you're likely to make. From the perspective of many *Maximum PC* readers, then, Oculus is already within reach.

What will be interesting to see is how game developers leverage the available hardware, and that's always been a sticking point in the console versus PC debate. By defining a relatively high recommended system, Oculus opens the doors for full DX12 support and advanced rendering features. But developers often want to increase the available installation base, so they create lower-quality rendering paths. Considering the Oculus Rift shipping hardware is likely to cost well over $300, however, it's not too much to expect gamers to have commensurate hardware elsewhere.

The final Rift hardware is now shaping up, and it will include an Xbox One controller. Oculus has also revealed an Oculus Touch controller, but that will ship after the initial hardware. We have the Oculus Rift DevKit 2 (DK2), and setting it up can be frustrating—getting the head tracking to work, in particular, was more difficult than it should be. The final hardware now includes a desk-mounted sensor that we're hoping will be easier, not to mention a single cable to the headset for audio, video, data, and power. The combination should help reduce the space requirements, but for a standing-up experience, you'll need a decent amount of room.

While there's a lot of potential in VR, it's a chicken-and-egg dilemma. Developers need hardware in the hands of more consumers to make money creating games. Consumers, however, want compelling software before they buy expensive hardware. And everyone wants the entire experience to be as hassle-free as possible. We're not there yet, which is why Oculus Rift isn't expected until Q1 '16.

When we consider the competing hardware and platforms, such as SteamVR, HoloLens, Project Morpheus, OSVR, and Gear VR, it becomes far less clear who'll win this shootout. Oculus kick started—or Kickstarted—the current VR craze a few years back, but it isn't the only game in town. It remains to be seen whether we'll have multiple complementary platforms or a single winner-take-all solution. As exciting as VR is, no one wants to get stuck owning a virtual Betamax setup. ⏻

BENCHMARKS

	ZERO-POINT	
Premiere Pro CS6 (sec)	2,000	1,141 (43%)
Stitch.Efx 2.0 (sec)	831	753 (10%)
ProShow Producer 5.0 (sec)	1,446	911 (37%)
x264 HD 5.0 (fps)	21.1	18.4 (-13%)
Batman: Arkham City (fps)	76	64 (-15.8%)
3DMark 11 Extreme	5,847	4,616 (-21.1%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% 110%

Our current zero-point consists of a hexa-core 3.2GHz Core i7-3930K 3.8GHz, 8GB of Corsair DDR3/1600, on an Asus Sabertooth X79 motherboard. We are running a GeForce GTX 690, an OCZ Vertex 3 SSD, and 64-bit Windows 7 Professional.

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GTX 980 Ti
NVIDIA

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Nvidia GeForce GTX 980 Ti

Titan X's younger brother wins the popularity contest

GTX 980 Ti
NVIDIA

The reference 980 Ti looks just like the Titan X, minus the black shroud.

WE ALL KNOW THE TYPE: the ultra-cool guy with the best hair, the right clothes, and the hottest car. The problem is that trying to make friends with such a person can be difficult… and will cost you. But did you know the coolest guy in town has a little brother who's much more down to Earth? Oh, he still dresses right and drives a nice car, but he's not quite so ostentatious. The little brother is named GeForce GTX 980 Ti, son of Nvidia and sibling to the Titan X.

The 980 Ti hardly comes as a surprise. Nvidia uses the fully enabled GM200 GPU in the Titan X, so a version with some functional units disabled was inevitable. The same thing happened with the original Titan and the GTX 780 Ti, though this time there's no improved FP64 mode on the Titan X, so saving money and getting nearly the same performance is hardly a bad thing. The 980 Ti uses the same GM200 processor, but disables two of the 24 Streaming Multiprocessors (SMs), dropping the total shader count from 3,072 to 2,816. Nvidia also ships the 980 Ti with 6GB VRAM instead of 12GB, though practically speaking, that isn't likely to matter much, as 12GB is overkill.

Outside of those changes, the two cards share the same specifications. And no, there are no memory-partitioning shenanigans like with the GTX 970; the 980 Ti has full access to the 6GB GDDR5 memory. The 980 Ti also has the same 250W TDP as the Titan X. This will prove interesting, as there are times when the Titan X gets close to its TDP limit; when that happens, the 980 Ti could end up providing identical performance.

Since it's not part of the Titan lineup, graphics card vendors are also free to differentiate their designs with modified cooling configurations and clock speeds. We've already seen dual-fan and triple-fan open-air coolers from the likes of EVGA and Zotac, and these boost the default clock speeds anywhere from 100 to 250MHz. And speaking of overclocking, we were able to push the clock speeds of our reference 980 Ti up to 1,250MHz core and 3,905MHz GDDR5; this resulted in a healthy 10–20 percent improvement in gaming frame rates across all of our tested games. Nice!

We've made some changes to our test suite as well as our test bed recently, adding *GTA V* and *The Witcher 3* to our list. They're both Nvidia-friendly titles, as are *Batman: Arkham Origins* and *Shadow of Mordor*, but we've some AMD-friendly games as well (*Hitman: Absolution*, *Metro: Last Light*, and *Tomb Raider*). For our test bed, we've moved to Haswell-E and the X99 platform, with a Core i7-5930K running overclocked at 4.2GHz to ensure we're not holding back performance of any of the graphics cards.

PEDAL TO THE METAL

The GTX 980 Ti is a force to be reckoned with. Running against a collection of the fastest single GPU cards, it's a photo finish against the Titan X. And outside of bragging rights, no one is really going to be able to tell the difference between the two. Yes, the more expensive card wins by a nose, but unless you're running a setup that needs more than 6GB of VRAM, there's no real benefit. The 980 Ti is also 25 percent faster than the 980, 40 faster than the 290X, and 60 faster than the 970. And if you're running a GTX 770 or 680, the GTX 980 Ti will more than double the performance, never mind the added VRAM that makes QHD and 4K Ultra quality in recent releases playable.

In short, the GTX 980 Ti is awesome! You effectively get Titan X levels of performance while saving $350. With an increasing number of games moving beyond using 4GB VRAM at maximum quality, the 980 Ti ensures you have enough memory, and tosses in a bunch of bandwidth and shaders as a bonus. The ball is in AMD's court, and it's in the process of launching its new Fury cards as we go to print. Priced at $549 for the Fury and $649 for the Fury X, AMD looks competitive, but the 4GB VRAM is a potential concern. We'll have the full results next issue.

–JARRED WALTON

VERDICT
9
KICK ASS!

Nvidia GeForce GTX 980 TI

+ HOT RODS Excellent performance; custom cooling options; quiet; overclocks well.

− HOT DOGS Still expensive.

$649, www.nvidia.com

SPECIFICATIONS

GPU	GM200
Lithography	28nm
Transistor Count	8 billion
Die Size	601mm^2
SMs	22
Shaders	2,816
Texture Units	192
ROPs	96
Core Clock	1,000MHz
Boost Clock	1,076MHz
Memory Capacity	6,144MB
Memory Clock	3,505MHz
Bus	384-bit
TDP	250W

BENCHMARKS

	GTX 980 Ti	Titan X	GTX 980	R9 290X	GTX 970	GTX 770
Batman: Arkham Origins (avg fps at 1440p/4K)	**110 / 53**	**110 / 53**	85 /42	81 / 40	67 / 32	61 / 0
GTA V (avg fps at 1440p/4K)	46 / 24	**47 / 24**	38 / 20	31 / 15	29 / 14	21 / 0
Hitman: Absolution (avg fps at 1440p/4K)	**63 / 32**	**63 / 32**	50 / 25	53 / 28	40 / 19	34 / 17
Metro: Last Light (avg fps at 1440p/4K)	**69 / 37**	**69 / 37**	60 / 31	52 / 27	46 / 24	38 / 19
Shadow of Mordor (avg fps at 1440p/4K)	**81 / 46**	**81 / 46**	68 / 38	63 / 37	51 / 28	31 / 17
Tomb Raider (avg fps at 1440p/4K)	86 / 43	**91 / 44**	73 / 35	58 / 29	55 / 26	41 / 9
Unigine Heaven 4.0 (avg fps at 1440p/4K)	60 / 25	**61 / 27**	48 / 20	38 / 16	34 / 15	28 / 12
The Witcher 3 (avg fps at 1440p/4K)	**45 / 28**	**45 / 28**	37 / 22	28 / 19	28 / 17	17 / 5

Best scores are bolded. Our test bed is a 4.2GHz overclocked Core i7-5930K in a Gigabyte GA-X99-UD4 motherboard, with 4x 4GB DDR4-2666, and an EVGA SuperNOVA 1,300W G2 power supply. The OS is 64-bit Windows 8.1. Graphics drivers are 352.90 and AMD 15.5 Catalyst Beta.

The Tiki is much smaller than you might think.

Falcon Northwest Tiki

Powerhouse PC in a small package

BACK IN THE DAY, in order to get an exorbitant amount of PC power, you really needed a hulking desktop. The more likely it was to break your back when lifting, the more badass it could generally be expected to be. While a bigger box may give you more legroom for power, Mini-ITX systems are giving the behemoths a run for their money in performance these days. On that notion, Falcon Northwest set out to deliver "godlike power" in its Tiki micro-tower. After testing it in our lab, we think even Zeus would be proud.

In terms of offering performance per cubic inch, Falcon Northwest asserts that there's no better Mini-ITX case than its Tiki chassis. The box measures about four inches across, is made of steel and sandblasted aluminum, and has a big stone base to keep it stable. While it certainly will keep the Tiki from toppling over easily, some might not like its ornate aesthetics. It looks a bit like a trophy stand your dad might display in the living room. In addition, it doesn't allow you to lay the Tiki on its side. This is most likely intended, however, considering there are vents on both side panels. There are also vents on the top. Ours is a deep shade of blood-red, which may not be for everyone, but the box also comes in black and other colors.

Despite the case's small stature, Falcon Northwest was able to cram Intel's top-tier 3GHz Core i7-5960X CPU and 16GB of 2,400MHz RAM into our configuration. All of this sits atop ASRock's X99E-ITX mobo, which ASRock flaunts as being the first X99 Mini-ITX motherboard. No compromises were made in the graphics department either, as our system came with Nvidia's top-of-the-line GeForce GTX Titan. This bad boy has a GPU clock of 1,102MHz, memory clock of 1,803MHz, and comes with 12GB of VRAM. And just because this box is heavy on processing power, doesn't mean it's light on storage.

Our unit sports Intel's 750 Series 1.2TB PCIe SSD, which garnered ridiculous sequential read and write speeds of 1,527MB/s and 1,299MB/s, respectively, in our CrystalDiskMark benchmark. That's boggles-the-mind fast. Sadly, system boot time with the drive was a lethargic 42 seconds. It looks like there are still some kinks to work out with PCIe SSD boot times. But just because we've got over a terabyte of SSD space, doesn't mean there isn't a massive storage drive. On the contrary, Falcon plopped in a whopping 6TB Western Digital Red drive. On paper, this system is such a tiny little beast that we could cry little tears of joy… if we weren't so manly.

SILENT AND SUPREME

When it came time to perform, the Tiki stepped up to bat. Its Asetek water-cooled 5960X beat our zero-point's equivalent 5960X by roughly 4–8 percent in our CPU tests. It didn't perform as well in gaming tests, losing by about 40–45 percent, but that's to be expected considering we're running three 980s in SLI on our ZP.

Perhaps the best real-world question you should ask of this system is, "Can it game at 4K?" The answer is a resounding "Yes." As a matter of fact, technically, it can play most games at 4K on max settings. It won't be able to do it at a silky-smooth 60fps, but even running the *Witcher 3* at 4K on max settings (an extremely taxing game), it managed to garner average fps in the low 30s, which is impressive. While that's technically playable, we would opt to decrease the graphics settings for a smoother experience.

Perhaps the most impressive thing about the Tiki, however, is that it stayed eerily quiet. At idle, it's damn-near silent. Generally, when you cram this much power into such a small form factor, these little rigs tend to scream for air. Falcon must have employed some black magic to this box, or applied good thermal engineering (but we prefer to think it's the former).

The Tiki isn't perfect, however. We had some small gripes in that its audio ports aren't labeled, there's no eject button for the slot-loading optical drive, and the case is kind of a bitch to open and close. Plus, the box is going to run you around $6K (ours runs $6,022 as painted; the default black paint job costs $400 less), which isn't cheap. But, in the end, it wins by delivering enormous power in a small, beautiful form factor, and remarkably quietly. There's not much more you could ask for. **–JIMMY THANG**

VERDICT 9 KICK ASS!

Falcon Northwest Tiki

+ NORTH BY NORTHWEST Powerful; quiet; relatively small; lots of storage.

− NORTH BY KANYE WEST Not cheap; hard to open/close; slow boot time.

$6,022, www.falcon-nw.com

BENCHMARKS

	ZERO-POINT	
Stitch.Efx 2.0 (sec)	806	768 (4.9%)
Proshow Producer 5 (sec)	1,472	1,363 (8.0%)
X264 HD 5.0	33.8	35.4 (4.7%)
Arkham City GOTY (fps)	204	122 (-40.2%)
Tomb Raider (fps)	87.5	50.5 (-42.3%)
3DMark Firestrike	8,016	4,381 (-45.3%)
Shadow of Mordor	70.1	51.3 (-26.8%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a Core i7-5960X CPU, three GTX 980s, and 16GB of RAM. Arkham City tested at 2560x1440 max settings with PhysX off. Tomb Raider at Ultimate settings. Shadow of Mordor at Max settings.

SPECIFICATIONS

Processor	3GHz Intel Core i7-5960X
Mobo	ASRock X99E-ITX/ac
RAM	16GB of DDR4 2,400MHz
Graphics	GeForce GTX Titan X
Storage	1.2TB Intel 750 Series PCIe SSD/6TB HDD
Optical	TEAC DV-W28SS-B Slot-Loading DVD Super Multi Drive
Case/PSU	Custom/600-watt

This case is gorgeous—from the thick aluminum panels to the incredible finish.

Phanteks Enthoo Evolv ATX

A feature-packed modder's dream

SO, WHY IS THIS EVOLV ATX so much better that the ITX version, or the original Evolv Phanteks, released way back in September 2014? Quite simply, it's the build quality. This isn't a cheap case. Indeed, many might wince at paying $130 for a chassis. But then you unpack it. And then you take a look at what's included, and the stunning build quality that's been achieved. You quickly begin to appreciate what Phanteks has managed to achieve at such a low (yes, low) price point.

The case itself is made up entirely of solid 3mm-thick aluminum panels situated on top of an all-steel chassis. That gives it a hefty, solid dependability, plus also makes a lovely "ding" noise when you flick it. The sound, admittedly, isn't a vital case-buying prerequisite, but it's nice to hear, all the same. There's little-to-no flex in any of the panels (including the windowed side panel), all of which have sound-dampening foam on the joins, preventing any excess noise from vibration.

The case itself is incredibly modular. Indeed, it's a modder's dream. Supporting up to seven 3.5-inch drives (five with the included brackets) and four 2.5-inch drives (two included), it's neatly partitioned into two separate compartments for your power supply and motherboard. There's also plenty of room in the back for cable management, plus it includes some of Phanteks's Velcro cable-tidy straps and a multitude of tie-down points.

The chassis also has a vast array of features, including a sliding radiator bracket in the top. This can easily be removed for quick installation of all-in-ones or radiators, hinged and removable side-panel doors, plus support for a refridgerated truckload of water-cooling components. And the goodies keep on coming—Phanteks also supports several places to mount a pump for water cooling, thanks to the included pump bracket.

The case itself doesn't feature a 5.25-inch bay—for an optical drive, for example, though this is something we don't really see as a necessity anymore. Besides, in a world of streaming and USB solutions, it's not that expensive to simply go out and buy an external drive for the rare times that you actually find yourself needing to burn something onto a disc.

PREMIUM PASSION

As far as negatives go, the front I/O consists of two USB 3.0 ports and a headphone and microphone jack. It would've been nice to have seen an additional two USB ports here, especially for an ATX case of this size. Additionally, while the perforated floor separating the power supply from the motherboard allows for ample airflow, it would've looked a lot cleaner aesthetically if the panel was solid.

All in all though, this chassis is definitely worth buying for those looking to invest in a premium case with plenty of room to maneuver. It's incredibly clean and has an air of professionalism about it, with a kind of poised flair. Think Jaguar F-Type. Sophisticated, yet elegant. Put simply, we love this case. **–ZAK STOREY**

VERDICT
9
KICK ASS!

Phanteks Enthoo Evolv ATX

+ **TITANIUM SILVER** Crisp; good-looking; stunning build quality; superb water-cooling support, feature packed.

- **IT'S GRAY** Perforated PSU floor; front I/O could be better.

$130, www.phanteks.com

SPECIFICATIONS

Form Factor	E-ATX (up to 264mm), ATX, microATX, Mini-ITX
Dimensions & Weight	235 x 495 x 510mm; 10.2kg
Cooling	*Front:* 3x 120mm/2x 140mm (2x 140mm included); *Top:* 3x 120mm/2x 140mm; *Rear:* 120/140mm (1x 140mm included)
CPU Cooler Clearance	194mm
Graphics Card Max Length	420mm (no HDD brackets); 300mm (with HDD brackets)
Storage Support	4x 2.5-inch SSD mounts; 7x 3.5-inch HDD mounts

Kingston HyperX Savage 240GB

HYPERX
SAVAGE

Performance soothes the savage beast

TECH NAMING CONVENTIONS are becoming a parody of themselves. Here, we've got a solid-state drive that Kingston wants to describe as "savage." As well as "hyper." With an extraneous "X." We've seen more savage things at retiree quilting clubs.

But, compared to some of the SSDs we've seen from Kingston, we'll accept that this latest drive has some call to use the HyperX label. It's impressively speedy, and not just when compared to some of its more pedestrian stablemates. Put up against Samsung's 850 EVO, resplendent with its 3D memory and in-house MGX memory controller, this Kingston effort manages to keep pace, and, in some instances, actually outperform it.

We've got to say (while refusing to acknowledge its barbaric subtitle anymore), the thing that really gives this latest HyperX the performance that Kingston has been craving so badly is that eight-channel Phison PS3110-S10 memory controller. The last HyperX SSD we tested was still using the aging SandForce controller, effectively making it a real-world irrelevance, especially when the likes of Crucial and its half-terabyte MX100 drives were making fools of just about the entire industry.

It's not the first Kingston drive to pack a Phison controller. The SSDNow 310 was rocking an older version. It was a version that definitely wasn't going to set the storage world alight, but in the relatively affordable high-capacity end of the solid-state storage market, it kinda made sense. Speed in that sector is less important than capacious data stores.

FLY, YOU FOOL

For the HyperX brand, though, pace is most definitely paramount. And here, the current Phison controller, coupled with the 19nm Toshiba MLC NAND, delivers performance that almost puts it ahead of even the 512GB Samsung 850 Pro. Compared with the similarly priced 250GB 850 EVO, this Kingston takes the plaudits in terms of the peak and average sequential benchmarks. It's impressive stuff.

It's a little behind on the random 4K read/write speeds, but not by much. It's certainly up there with the main contenders in the SATA 6Gb/s world. But yes, we're still talking SATA. NVMe drives remain rarer than a non-cynical tech journalist, and both the Samsung 850 drives and this latest Kingston are bumping their heads against the limits of the interface. Much as SSDs have been doing since the SATA 6Gb/s interface met NAND flash.

Where the Kingston drive does show a bit more of a tangible improvement over the competing Samsung drive is in the real-world file compression and data transfer tests. Indeed, it's almost 20 seconds quicker on our hefty 30GB Steam folder transfer than the 3D memory-laden 250GB Samsung EVO.

But it's still slower than the larger 500GB Samsung, with its greater parallel performance, though we don't know whether the eight-channel Phison controller will deliver the standard speed hike that now comes with higher capacity. We'll need to get our hands on the big brother of this drive to figure that out.

What we can say is that Kingston's latest HyperX SSD does finally offer genuinely competitive storage performance, and in a world hobbled by the SATA interface, that's pretty much all you can ask for. A drop in price would be nice, but considering this drive's just 54 cents per GB, it's not exactly terrible value.

But would we recommend the Kingston over the Samsung? Probably not. Performance is there in spades, but the consistency tests show it's a little more prone to performance spikes than the 850 EVO, when really being pushed. And then there's the warranty. There's still the longevity fear with solid state, and having the five-year, as opposed to three-year, warranty definitely inspires confidence. But it sure is close. **–DAVE JAMES**

BENCHMARKS

	Kingston HyperX Savage 240GB	Samsung 850 EVO 250GB
Peak Sequential Read/Write (MB/s)	**558/537**	553/532
Average Sequential Read/Write (MB/s)	**500**/481	495/**485**
Random 4K Read/Write (MB/s)	37/95	**39/107**
5GB File Compression (secs)	**76**	82
30GB Folder Transfer (secs)	**218**	236

Best scores are bolded. Tests were carried out on an Asus ROG Z97 Hero motherboard and a stock-clocked Core i7-4790K, with 8GB DDR3 at 1,600MHz.

VERDICT 8

Kingston HyperX Savage 240GB

➕ **SOPHISTICATED** Speedy Phison controller; good value; impressive real-world performance.

➖ **SAVAGE** Stupid name; limiting interface.

$130, www.kingston.com

SPECIFICATIONS

Memory Controller	Phison PS3110-S10
Memory	Toshiba 19nm MLC
Capacity	240GB
Form Factor	2.5-inch
Connection	SATA 6Gb/s
Warranty	Three years

The Cubi produces the tiniest noise, from a heatsink, that's only audible with your ear right next to the device.

MSI Cubi

Fantastically small home theater PC in a box

IF THE MSI WIND BOX was really just a tub of hot air, then the Cubi is a hurricane. A very good-looking hurricane. Sleek and small, with a clean design, our review sample is a treasure trove of golden hardware. It's everything the Wind Box should've been.

Around 1mm taller than Intel's latest NUC, the Cubi's slightly sloped, edgy physique gives it a much more arresting and elegant look than its rival. It's almost a shame that it's VESA-mountable, meaning most will be slapped to the back of a TV, as the pristine, glossy-white chassis really does look quite at home on our desk.

Clearly, because of the size of this thing, it's not a powerhouse when it comes to performance. With a Cinebench score of 199 (almost double what its gusty cousin can produce), it loses out to the Intel NUC5i3RYK we tested in our June issue, but only by 20 points. However, it makes up for this by running as silently as the grave. Idling at around 50 degrees Celsius and peaking at 70. Under load it's almost impossible to hear any noise from the Cubi without physically slamming your ear next to the small little box of joy.

The storage situation is also far better than its little brother. Our review sample came with 120GB of internal flash storage by default (107GB left over after a quick install of Windows 10). But with access to an additional 2.5-inch drive, via an mSATA adapter, the Cubi can accommodate up to 1TB of additional SSD space, if you require it. This does increase the height of the Cubi by 12mm or so, but all in all, it's completely worth it for that expandability.

WELL-CONNECTED

Speaking of expandability, it also includes two SoDIMM slots, allowing up to a total of 16GB of RAM. Couple that with a Broadwell Core i5 and you have yourself one seriously boast-worthy work or home theater PC, one that you can fit into the palm of your hand, no less, and one that runs on an impressive 65W power supply.

IO is handled by a positive menagerie of connectivity, with the back featuring two USB 3.0 ports, Ethernet, Mini DisplayPort, HDMI, and power. The front also houses a four-pole input for headphone and microphone combos, plus an additional two USB 3.0 ports. It even comes with Wireless AC and Bluetooth 4.0, which is a must in today's modern age of high-speed gaming and streaming.

And did we mention this thing streams 4K? Because yep, although we guess that's not as impressive as we'd all like to think nowadays, there are still a lot of people out there using laptops that stutter playing 720p videos on YouTube. It's an impressive PC rolling in at $280 for the barebones Core i3 model, or $350 for Core i5 version.

The MSI Cubi comes in at a very attractive price point and performs admirably in competition against the Intel NUC and its own little brother, the Wind Box. For price to performance, you're not going to get any better any time soon.

All up, MSI seems well on the way to cracking the algorithm that will hopefully deliver the perfect, all-round Steam, office and home-streaming box. It's not 100 percent there yet, but it certainly looks promising for the future of micro-PCs. **–ZAK STOREY**

VERDICT 8

MSI Cubi

➕ **CUBE** Huge amount of expandability; relatively cheap alternative to Intel's NUC; looks gorgeous.

➖ **NOOB** Can be a bit challenging to get to work on certain monitors; SATA ribbon port feels flimsy.

$280, www.msi.com

BENCHMARKS

	MSI Cubi	Gigabyte Brix S
Cinebench R15 (index)	199	**252**
PCMark v8 (index)	1,781	**2,049**
Idle Temperature (°C)	**49**	53
Load Temperature (°C)	70	**69**
Idle Power Draw (W)	**9**	10
Load Power Draw (W)	**20**	24
1080p Video Power Draw (W)	**18**	19

Best scores are bolded.

SPECIFICATIONS

SKU	Cubi
CPU	Intel Core i3-5005U 2GHz
Memory	Up to 16GB DDR3L 1,600MHz
Storage	1x 2.5-inch, 1x mSATA
Network	802.11 ac WiFi card, Gigabit Lan
Video	1x HDMI, 1x Mini DisplayPort
I/O	4x USB 3.0, 1x 3.5mm headphone/mic
Dimensions (D x W x H)	115 x 111 x 35mm

Acer V17 Nitro Black Edition

This mainstream gaming notebook could use a shot of N_2O

The large 17.3-inch display hides some relatively tame hardware underneath.

A NAME LIKE V17 Nitro Black Edition inspires images of fast cars and powerful engines. Acer, not normally a company associated with high-performance systems, might be trying to change its image, it seems. And indeed, on the surface, the V17 packs some decent hardware, such as a gimmicky 3D RealSense camera. But while some parts are good choices, others leave us wanting.

The V Nitro series is available in two sizes, the 15.6-inch V15 and the 17.3-inch V17 we're reviewing. And that's where we first encounter some anomalies. Despite having a larger chassis, the V17 is only available with a 1080p display, where the smaller V15 is available with 1080p or 4K IPS displays. The battery is also a fairly small three-cell 52Wh capacity, which impacts battery life in a negative way. The core hardware is otherwise the same, so the only reason to go with the larger laptop is if you prefer lower-DPI displays. There is some good news—for gaming purposes, 1080p is a much better fit for the graphics card. But that brings us to the next concern: Acer's choice of Nvidia's GTX 960M.

There's a big gap in performance and features between the GTX 960M and 965M. The 965M uses a trimmed-down GM204 GPU, while the 960M uses Nvidia's first generation of Maxwell hardware, GM107. That means certain DirectX feature level 12.1 options are missing, along with VXGI (Voxel Global Illumination). The bigger concern is that the 965M offers 30–40 percent more performance compared to the 960M. In many games, that will be the difference between running high versus medium quality at 1080p.

Even though we think the GTX 965M would have been a better choice, the V17 still has decent performance; it surpassed our zero-point Alienware 14 in every test with the exception of battery life. Three hours of video playback is quite short, even for a mainstream gaming laptop, and if you happen to fire up a game, the V17 will only last about 45 minutes. Turning on Battery Boost can help, at the cost of frame rates, but getting more than an hour of unplugged gaming will prove difficult.

MIDDLE OF THE ROAD

What really separates great laptops from the merely average isn't just performance-oriented insides, it's the entire experience, and this is where the V17 falls short. The keyboard is quite good, we've no complaints there, but the clickpad is another matter. It's unresponsive and lacks precision, and while any gaming on this laptop will almost certainly be done with an external mouse, there's no reason the integrated trackpad shouldn't work well. It's 2015—getting the trackpad right should be a simple matter.

That's not the only flaw we encountered. There's a phenomenon known as "coil whine" that typically occurs when a small capacitor or coil begins to vibrate and emit a high-pitched noise. We've seen this on GPUs, motherboards, and network adapters, but in the case of the Acer V17, our test laptop exhibits the problem when the GTX 960M fires up. Do anything without engaging the discrete GPU and it's fine, but as soon as a game starts running, we hear a high-pitched noise. This problem is usually unit-specific, so while this particular V17 has coil whine, another V17 may not, but it does speak to issues with quality control.

The V17 is decent overall, and the size and modest performance allows it to run without making a lot of noise. The price is attractive, especially now you can find it for $200 under the MSRP, but there are many competitors with higher-quality materials that simply look better, and they don't fail the touchpad test. If you like large displays and are after a mainstream gaming notebook, you could do far worse for the price.

–JARRED WALTON

VERDICT
7

Acer V17 Nitro Black Edition

+ V8 ENGINES Nice IPS display; good keyboard; runs quiet.

− V8 JUICE Underpowered for 17.3-inch; poor trackpad; coil whine.

$1,499, www.acer.com

SPECIFICATIONS

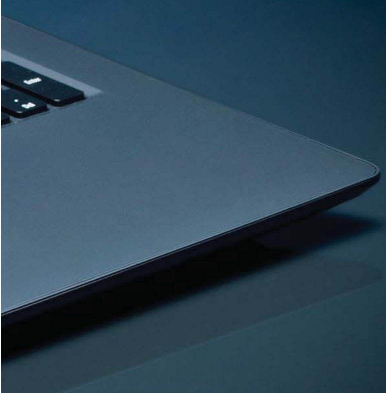
CPU	Intel Core i7-4720HQ
RAM	2x 8GB DDR3L-1600
GPU	GeForce GTX 960M 4GB
Display	17.3-inch, 1920x1080 IPS
Storage	256GB SSD, 1TB HDD, DVDRW
Connectivity	HDMI, Ethernet, SD reader, 2x USB 3.0, 2x USB 2.0, 802.11ac, Bluetooth 4.0
Dimensions	16.7 x 11.5 x 1 inches
Weight (Lap / Carry)	6.61 / 7.89lb

BENCHMARKS

	ZERO-POINT	
Stitch.Efx 2.0 (sec)	962	913 (5%)
ProShow Producer 5 (sec)	1,629	1,537 (6%)
x264 HD 5.0 2nd (fps)	13.5	14.36 (6%)
BioShock Infinite 1080p (fps)	36	57 (58%)
Metro: Last Light 1080p (fps)	30	50.8 (67%)
3DMark 11 Performance (fps)	4,170	5,664 (36%)
Battery Life (1080p video, mins)	234	172 (-26%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point notebook is an Alienware 14 with a 2.4GHz Intel Core i7-4700MQ, 16GB DDR3-1600, 256GB mSATA SSD, 750GB 5,400rpm HDD, GeForce GTX 765M, and Windows 7 Home Premium 64-bit. *BioShock Infinite* tested at 1920x1080 at Ultra DX11 settings; *Metro: Last Light* tested at 1920x1080 at DX11 medium quality settings with PhysX disabled.



Samsung S34E790C

Curved but not completely crazy

THIS IS NONSENSE. This, we'd argue, would be any sensible person's default initial reaction to the new Samsung 34-inch übertron with a curved LCD panel. Like stereoscopic 3D displays or 200Hz TV sets, the technology of curved LCD screens is real enough. But surely it only exists as a marketing tool, not because it enhances the viewing experience?

Curved screens certainly qualify for gimmick status in the HDTV market. After all, the only way a curved screen can possibly work is when you're positioned in the perfect place. In other words, you need to be sitting exactly in the sweet spot of the circle of which the screen curve forms a segment, and that is rarely the case with a TV. You're probably too far away and sitting at least slightly off-center, especially if more than one person is watching.

For a PC monitor, it's perhaps not such a crazy idea. Using a PC is much more likely to be a solitary affair and you'll indeed be sitting dead center in front of the screen. So, it's just a question of tweaking the distance to the screen and its height to hit the right spot.

MORE THAN A GIMMICK?

The problem is, even perfectly positioned, the Windows desktop still looks very weird with a curved screen. No matter where you sit, the geometry of the Taskbar looks badly bent. Actually, it had us eyeing the bottom and top bezels like a master craftsman, trying to work out the shape of the panel. It is indeed perfectly straight along each side, which we knew. But the visual weirdness has you doubting what you instinctively know to be true.

Get in-game, however, and things suddenly look a lot more clever. Without screen elements like the Taskbar constantly reminding you of the shortcomings of a curved panel, you can simply enjoy the subtle wrap-around feeling. Admittedly, it's a little difficult to pick apart the curved aspect of this panel from its overall proportions and dramatic widescreen format. With 3440x1440 pixels and a 21:9 aspect ratio, this screen would be spectacular even without the curve.

However, we've seen 34-inch 3440x1440 monitors with flat, rather than curved, panels before. They're stunning things, but there's definitely a sense that the far edges of the screen are a long way off and viewed at a conspicuously oblique angle.

Overall, then, the benefit of a curved panel is tangible, if subtle, in games. If it's something you appreciate, the next question is whether this Samsung effort is a good example of the breed. The stand is adjustable for both height and tilt, which is particularly important for a curved screen where your viewing position is so critical.

Then there's the image quality. At default settings, the color temperature is very cold, blue, and subdued. Weirdly, we had to enable the "game" mode in the menu to get colors that looked more vibrant, but it still didn't look terribly natural.

A quick perusal of the spec sheet reveals the probable explanation. The S34E790C has a VA rather than IPS or TN panel. Except at the very high end, VA panels tend to have slightly wonky color balance. And so it is here. That said, VA also delivers fantastic contrast and black levels.

Factor in the punitive pricing and this Samsung is a marginal propostion. There are 40-inch 4K monitors that can be had for less, for instance. More to the point, so can 34-inch curved monitors with IPS panels, such as Dell's UltraSharp U3415W. Even at the same price, the likes of the Dell is probably where our money would go. For less money, it's a no-brainer. **–JEREMY LAIRD**

VERDICT 7

Samsung S34E790C

+ BENDING THE RULES Spectacular wrap-around in-game visuals; VA panel packs plenty of contrast and black levels.

− JUST BENT Curved geometry looks weird in Windows; poorly calibrated colors; expensive against competition.

$1,190, www.samsung.com

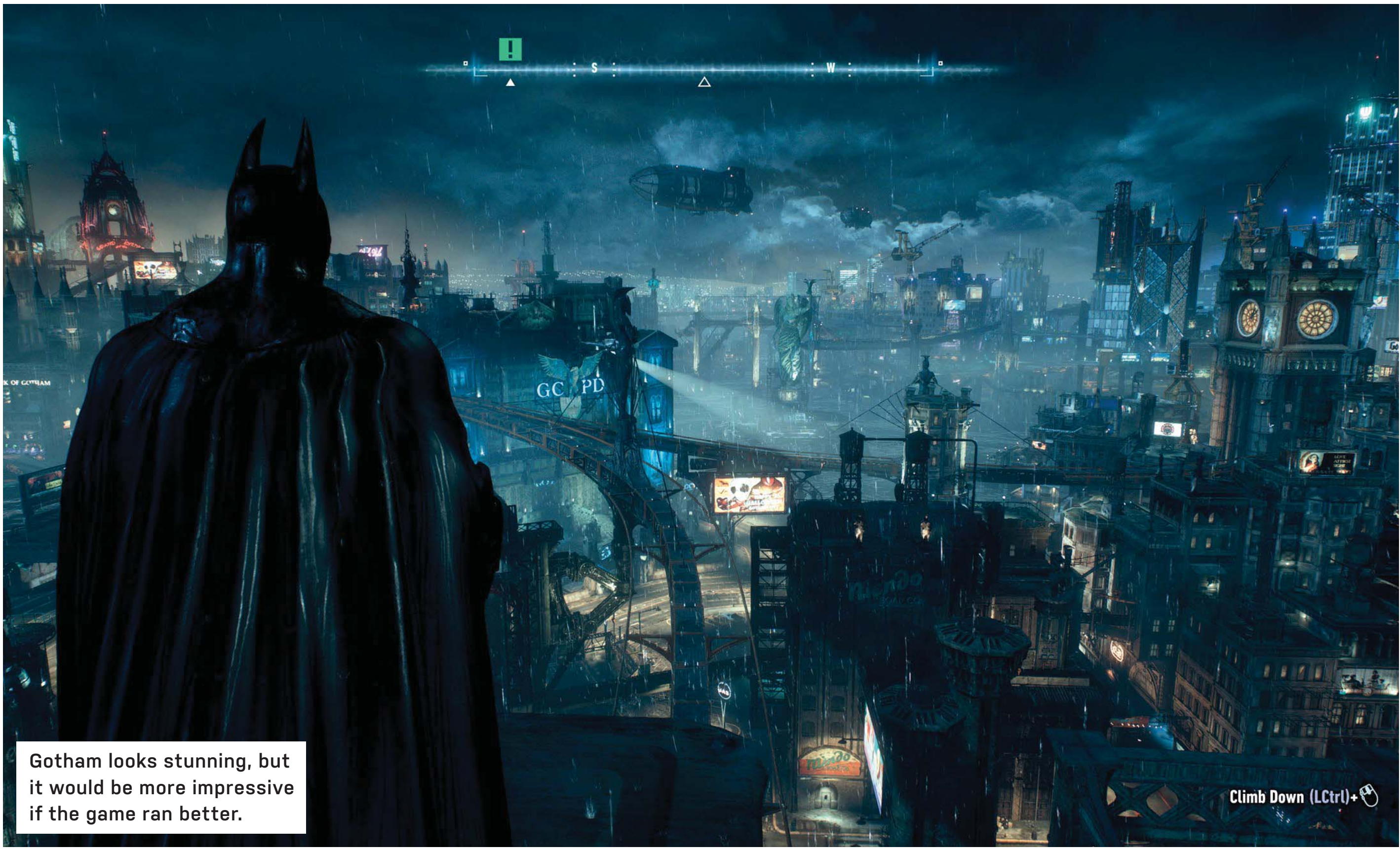
SPECIFICATIONS

Panel Size	34-inch curved
Panel Type	VA
Native Resolution	3440x1440
Refresh Rate	60Hz
Inputs	DisplayPort, 2x HDMI
Stand	Tilt, height (no VESA)

20
2917/3185
668/670

12:07
18
16
6
Chibitjuhh
Exitwarp
CAPTURE THE TEMPLE
SAMSUNG

The curved screen does offer in-game benefits, but the Samsung struggles to compete at this price.



Gotham looks stunning, but it would be more impressive if the game ran better.

Batman: Arkham Knight

Is there light at the end of this Dark Knight?

REVIEWING PC GAMES is sometimes tough. We're the ones who're supposed to shut up and like what we're given. "Oh, you're lucky the game was released at the same time as the super-special (resolution-degraded) console version," says Mr. Anonymous Publisher. "Hell, you're lucky you nerdy, copyright-thieving PC folk are even getting a version of our game at all."

So no, we don't get review versions. We rarely get early code any more at all. But even rarer still is that *no-one* in PC gaming gets review code for a Triple A title like a new *Batman* game from Rocksteady. Such was the case with *Arkham Knight*. And, from the subsequent fallout from the launch of this latest foray into the Dark Knight's tormented psyche, it could hardly be seen as cynical to suggest that maybe there was a good reason for PC game reviewers not seeing the buggy, stuttering game before it was released.

The weird 30fps cap on the PC version was quickly solved by an .ini tweak, but textures, rain effects, and ambient occlusion were missing, and it was all woefully optimized for different machines.

Which all led to the game being removed from sale, so that the devs, whether they be Rocksteady or PC port contractors Iron Galaxy, could fix it. It's the first time we can remember a Triple A game being withdrawn from sale like this. By the time you read this, though, it will be back on sale again. Already, the existing PC version has been patched to include the missing rain and AO effects, and performance has been improved. A little.

BEYOND THE LAUNCH

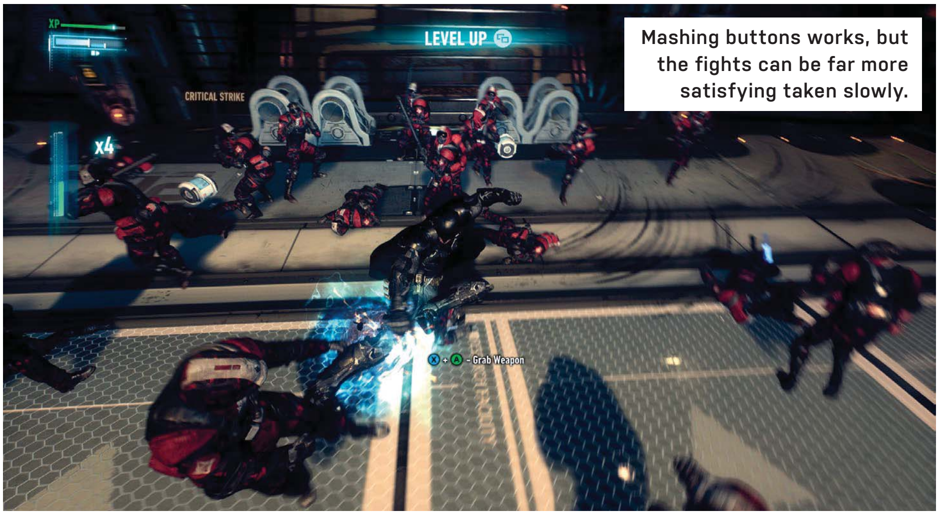
It is all incredibly tragic, because *Arkham Knight* is the best *Batman* game we've played since the wonderful, focused *Arkham Asylum*. We didn't want to spend the opening paragraphs talking about how ridiculous the recommended specs are, how woeful the game's performance is on different PCs, especially high-end ones, or the post-launch publisher recriminations.

We want to be talking about the excellent cast and their mostly impressive performances. How the script is really tight and how the game genuinely makes us feel like we're playing through an epic *Batman* comic series. So that's what we're going to be largely doing for the rest of this review.

One of the reasons we loved *Asylum* was because of just how focused the story, and subsequently the gameplay itself, was. Sure, it was linear, but it was tightly constructed and rattled along at such an engaging pace that you just had to keep going, keep turning one more page in this interactive comic.

The following games, *City* and *Origins*, traded that linear structure in for the more fashionable open world. And personally, we found that to the detriment of the series. You had more potential "gameplay" in a quantitative sense, because there were more little distractions to find around the various versions of Batman's playgrounds. But that's all they felt like to us; something to extend the playtime so it could be shouted about in the marketing. The stories felt weaker as a consequence.

Arkham Knight changes that. There's great pacing to much of the game, pulling you along from one glorious comic-book vignette to another. The main storyline contains some of the best characters from



Mashing buttons works, but the fights can be far more satisfying taken slowly.

The great cast fleshes things out.

There's a lot of boring drones to shoot.

Been loving the *Dark Knight Returns* costume.

Mark Hamill's Joker offers some ligh(er) relief to the bat.

the series and there are many excellent callbacks for fans of the comics, too, letting you see key moments in Batman's life as his tenuous grip on reality falters. Thankfully, not another origin mugging though.

The main thrust is a great mix of punchy bat-fun, cerebral and physical bat-puzzles, and bat-roping around the beautifully constructed, brooding Gotham City. Which, incidentally, feels more like the first Burton bat-world than anything. When it's running smoothly, with Gamework's powered rain and lighting effects, and with AO actually on and making the world less visually flat, it looks stunning. The rain now beads on Batman's suit—whichever you've unlocked from the various options on offer—and pools around his feet under the oppressive Hallowe'en rainstorm sweeping Gotham.

DOWN TO BAT BUSINESS

This time, though, it's not the weather keeping the actual Gothamites off the streets. They were all evacuated just after dinner to avoid sucking on Scarecrow's toxic hosepipe, which he's threatening to let loose on the city. Like the previous games, there's no civilians to worry about. All that's left on the streets are criminals, which means anyone's a target for the now-familiar fighting mechanics. They're typically solid, visceral, and, if you have the patience to learn, remarkably satisfying. If you're not paying attention though, they can descend into button-mashing very quickly.

What aren't so satisfying are the unnecessary shooting galleries. Batman doesn't have guns, but gamers like guns, right? So let's give him the Batmobile with loads of drone tanks to blow up, so Bats doesn't violate his "no killy" rule, but still gets to scratch that itchy trigger finger. We could happily do away with the tank battles. We don't really need any more guns in the world, do we? But sadly, they're a must-play in terms of the main story.

The extra "cases" you can choose to investigate between story missions though can be whole little comic mini-arcs of their own. You do get to play detective, too, and sometimes as other characters; not everything can be solved by a tank or a fist. The lengthy Catwoman/Riddler side quest is a highlight, while other fan-favorites appear, to greater or lesser extents, to cause our Bats some trouble. These don't feel like filler either. They're like special issues offering a break to the overarching epic storyline. There are the "gotta-collect-'em-all" kind of "cases" for the completionists out there, but these can happily be ignored to save room for the main meal.

We hope all the negativity that the car-crash launch injected into the PC version of *Arkham Knight* gets pushed aside, but not forgotten, once the game is re-released. It's a wonderful-looking game, when its frame rates aren't plummeting for no good reason, and textures are failing to load at high-resolutions. But more important than all that, it's a fantastic-playing game when the visuals play ball. The story is classic Bats and the game makes us feel like the world's (second; Holmes, obv.) greatest detective. It shouldn't have been released in its original state, both because of how it has affected most PC players and because it will inevitably, and probably irrevocably, harm this otherwise impressive game's reputation. –**DAVE JAMES**

VERDICT **8**

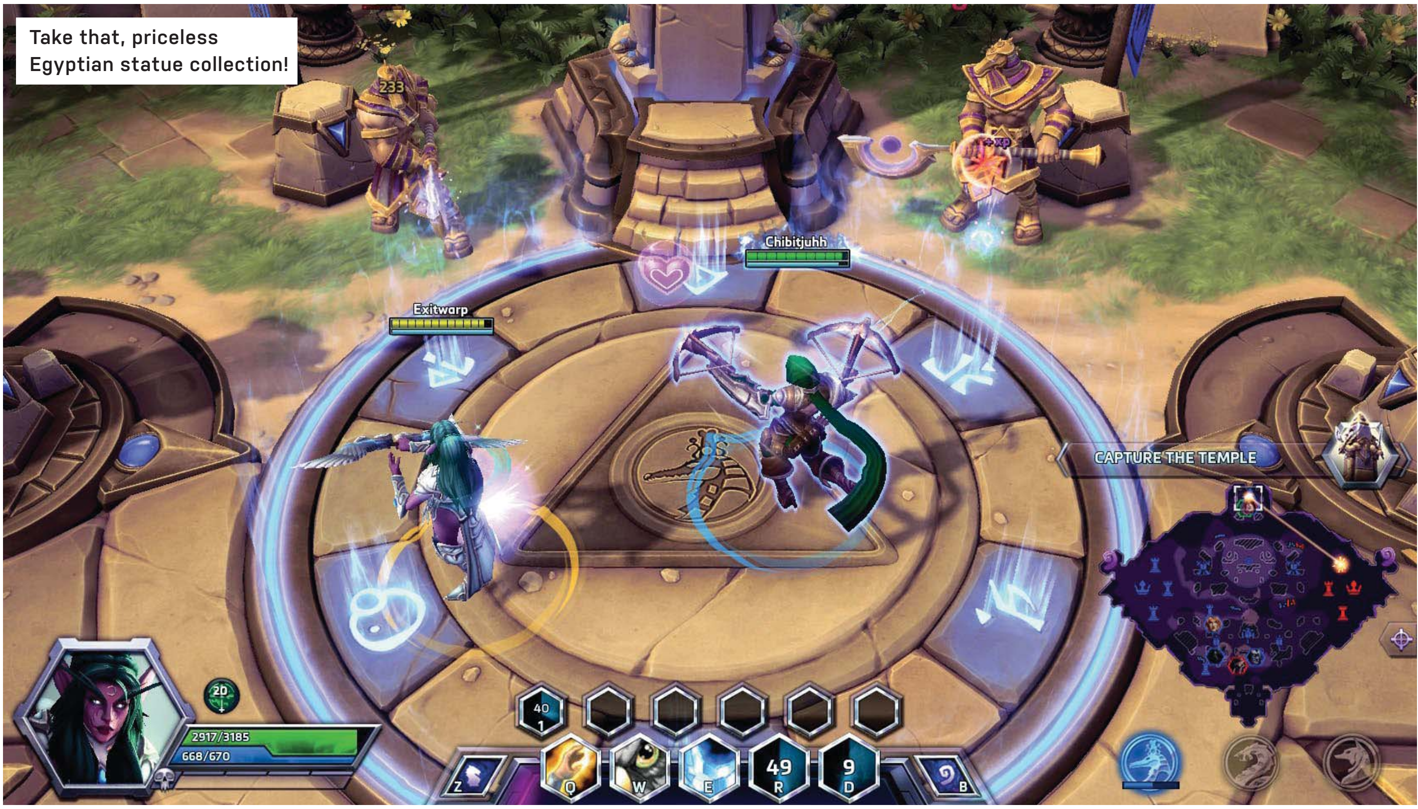
Batman: Arkham Knight

+ MICHAEL KEATON Engaging; often beautiful; great vocal performances; compulsive; comic-book.

− GEORGE CLOONEY Still kinda buggy; poor PC optimization; means crazy recommended specs; tedious tank-battles.

RECOMMENDED SPECS Core i7-3770 3.4GHz/FX-8350 4GHz; GTX 760; 8GB RAM.

$40, www.batmanarkhamknight.com, ESRB: M



Take that, priceless Egyptian statue collection!

Heroes of the Storm

A bridge-building ambassador for its genre

LET'S START BY SAYING this is not just another multiplayer online battle arena. It's a comment on the MOBA itself, by the company whose games inspired the genre. With it, publisher Blizzard steps into a territory it will find both deeply familiar and alien—a world of chunky characters and competitive strategy it embraces, alongside a fathomless homebrew complexity that it doesn't. This is a studio that's always valued accessibility, a belief strengthened of late by the success of *Hearthstone*. As such, *Heroes of the Storm* is a MOBA for people who don't play MOBAs. Perhaps even a MOBA for people who don't *like* MOBAs.

It'll be divisive, that's for sure. In designing *Heroes*, Blizzard has stripped away many of the ideas that previously defined the genre. Individual leveling is gone, replaced with a team-wide experience bar. Gold is gone, and with it items that boost your character's powers. Strategic drafting is gone, at least until you complete the long climb to competitive ranked play. For the majority of players, *Heroes* is a game where you pick who you want to play, click "Play," and play.

Doing so places you in a team of five fantasy heroes drawn from Blizzard's wide roster. Victory means pushing AI-controlled creeps from one side of the map to another along linear lanes. This means passing through the gateways, towers, and fortresses that amount to your opponent's outer defences, and when one team's core falls, the game is over. Here the comparisons to other MOBAs end.

There are seven maps, each offering a different layout and set of objectives. In Sky Temple, capturing shrines and defeating guardians grants you a building-felling laser. In Blackheart's Bay, collecting coins for a ghostly pirate allows you to turn his cannons on your enemy. In Haunted Mines, the titular caverns amount to a side-dungeon where you gather undead skulls to power up your hulking golem.

Diverse as individual objectives are, they amount to the same thing—a reason to fight elsewhere. Sit in one place clicking minions and you'll be quickly overwhelmed as your opponent takes control of the map, and with it the neutral monsters and bosses that can be defeated and recruited.

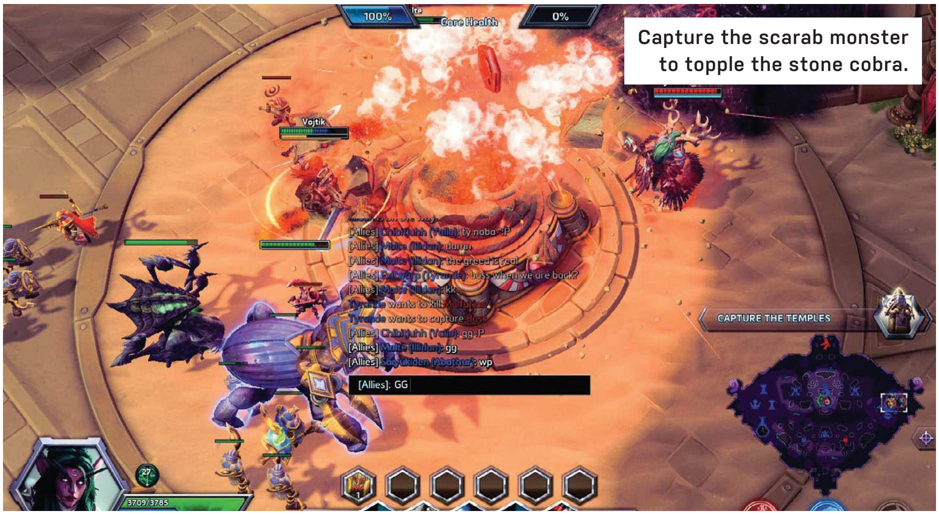
All heroes begin with three abilities alongside a passive power (though these sometimes have an active component) and earn an ultimate when their team reaches level 10. It often feels like entering a *Dota 2* match in the middle, and within 15 minutes you can be playing out battle scenarios that would amount to the endgame of a 50-minute epic elsewhere.

These scenarios are likely thanks to a generous number of comeback systems. Games rarely feel lost within the first few minutes. Teams that are behind receive bonus experience, and the plurality of objectives means there's almost always something you can do to turn your fortunes around. You just need to work out what it is.

EASY ACCESS

These decisions make *Heroes of the Storm* the most accessible MOBA we've played. They amount to a striking simplification of the genre's vocabulary, boiling the most opaque sector of competitive gaming to a handful of verbs: attack, defend, capture, collect. It opens up the basic strategic pleasure of five-on-five fantasy battle to an audience that might never have tried it.

Coming to *Heroes* as players already heavily invested in this genre, we've found our attitudes continually shifting. There are times when we've felt like a rally driver on a go-kart track, yearning for a game where failure is more significant and victories mean more. We suspect this will be the experience of many MOBA players. The more cynical will write it off entirely.


Capture the scarab monster to topple the stone cobra.

[Allies] Chibitjuhh (Valla): ty naba ":P
[Allies] Malte (Illidan): damn
[Allies] Malte (Illidan): the greed is real
[Allies] Exitwarp (Tyrande): boss when we are back?
[Allies] Malte (Illidan): kk
Tyrande wants to kill Malfurion
Tyrande wants to capture Boss
[Allies] Chibitjuhh (Valla): gg :P
[Allies] Malte (Illidan): gg
[Allies] Saiyukiden (Abathur): wp
[Allies]: GG

100%
Core Health
0%
Vojtik
CAPTURE THE TEMPLES
3709/3785

Hiding in bushes: a universal rule of war.

21
19
100%
Kroah

Feed gold to a pirate for a go on his cannons.

01:23
Exitwarp
Right-Click to Pay
Paying Doubloons

Knowing when to hold back and defend is crucial.

Syrea
Exitwarp
Tokyo
Ensemble

Some abilities have gruesome effects.

22
21
17:26
100%
Core Health
Chibitjuhh
TEMPLES ACTIVATE IN 0:01

But we don't think that's fair. As much as it truncates the genre, *Heroes* preserves strategic concepts that are more advanced than those it removes. Items, skill builds, and so on are all knowledge barriers. With perseverance, every player will eventually move past them. In knocking down that barrier, Blizzard has created a game entirely about map control, timing, momentum, and combat finesse. Mastering them can only come with experience.

One of the ironies of its accessibility is that, in removing the obvious impediments, *Heroes* drops new players in the strategic deep end. Given the amount going on in any given map and the apparent "looseness" of the laning system, it's easy to lose matches quickly and not really know why. Play purely as a "hero brawler," and you'll find yourself outmaneuvered by players who understand there's a time to fight, a time to hide, and a time to sweep the map.

These considerations are just as compelling as "what item do I build next." *Heroes of the Storm* loses out in terms of systemic complexity and the creative potential that comes with it, but does an impressive job of introducing new players to the map-wide strategic element that makes these games so compelling. It may stumble, but not because it's accessible.

Although the feel of the game has improved since we first played it at Blizzcon 2013, *Heroes* doesn't match the high standard Blizzard has set elsewhere. This is particularly apparent in the case of the *Diablo* heroes. In their original incarnations, these are defined by the damage they dish out, by the sense of force imparted with every click. In *Heroes*, that edge has been stripped away. What would be a bone-crushing slam in *Diablo 3* becomes a weedy thump here.

POWER-DOWN

Heroes of the Storm's avatars occupy far more screen-space than their equivalents in *League* or *Dota*, and, combined with much smaller maps, this gives the sense of being a bigger kid in a smaller sandpit. On the other hand, abilities feel muted: stuns are short, damage is low, particle effects simple and brief. These two factors contribute to the sense that your individual power is limited.

Heroes doesn't live up to the best of Blizzard's visual work, either. These games have always looked like a teenager's sketchbook given life, but now it feels like it's been through the corporate photocopier one too many times. Blizzard's latter-day love affair with PopCap is evident in the detail—like the way turrets and gates screw themselves into place, *Game of Thrones* intro-style—but this doesn't make up for the general lack of atmosphere. The *StarCraft*, *WarCraft*, and *Diablo* universes, when seen through the same technicolor filter, lose their distinctiveness.

It is also, at present, a little too eager for your time and money. Although the worst excesses of account-wide leveling were excised during the beta, you still need to grind away to unlock every talent and skill. If you want to play outside of the rotation of free heroes, then you're looking at a week of daily quests to save up enough gold for one or two characters of your own. Unlocking ranked play takes about 40 hours, double that if you're not using a premium booster. It feels like a misstep in a game that otherwise doesn't provide you with many ways to gauge your growth.

In some ways, however, we feel more comfortable recommending *Heroes* than we do *Dota 2*. This is because Blizzard has created a MOBA that doesn't require you to commit your life, or even an entire week, to get something from it. The benefit for newcomers is obvious. The benefit for existing MOBA players is more subtle. We finally have a fit ambassador for the genre, and we hope it's the game that shows people who don't like MOBAs what they're missing.

–CHRIS THURSTEN

VERDICT

8

Heroes of the Storm

➕ **HERO** The most any studio has done to open up a complex genre to a new audience; inviting; entertaining; deceptively deep.

➖ **ZERO** Visuals aren't Blizzard's best; too eager to make you spend money.

RECOMMENDED SPECS Core i5/FX Series; 4GB RAM, GTX 970/HD 7790; 10GB storage.

Free, www.battle.net, ESRB: T

LAB NOTES

JARRED WALTON **SENIOR EDITOR**

Desktop Broadwell Has Landed

Save your pennies and wait for Skylake

AS WE WERE GOING TO PRINT, Intel's Broadwell for desktops landed on our doorstep. I spent the better part of two weeks testing, and retesting, Broadwell-DT. On the surface, there should be a lot more to get excited about, as this is the first 14nm desktop processor from Intel. The reality is that with Broadwell-DT being late, the next-gen Skylake architecture is just around the corner, making Broadwell-DT a questionable investment. I also ran into some early teething problems with mobo BIOS support, but that should hopefully be cleared up by the time you're reading this.

Perhaps in an effort to keep something in the tank for Skylake, the stock clocks of the Broadwell Core i7-5775C are quite tame, so the fastest Broadwell-DT processor often performs worse than the previous generation i7-4790K, and even the i7-4770K is a close match. Sure, Broadwell doesn't need as much juice, but that is more relevant for laptops and notebooks, not desktops. Overclocking thankfully remains unlocked, and despite BIOS issues, we were able to push our early sample to 4.2GHz; even then we only saw a 5–10 percent performance increase over the i7-4790K.

The bigger benefit of Broadwell-DT is that it ships with Intel's fastest-ever graphics configuration, Iris Pro Graphics 6200. Performance is quite good, roughly doubling the performance of the HD Graphics 4600 in Haswell and generally managing greater than 30fps at 1080p medium. However, anyone with even a moderate GPU (GT 740/ R7 250 or above) already has a superior graphics solution.

The 128MB eDRAM/L4 cache is interesting, improving both graphics as well as general performance. But if you've been hoping for a significant upgrade from Haswell, Broadwell-DT won't impress you much. Hang on for a few more months and Skylake should be available, with a new platform and architecture that should prove more beneficial.

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02193

The bigger chip is Broadwell; the smaller chip is the 128MB eDRAM L4 cache.

ALEX CAMPBELL

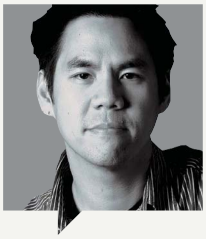
Associate Editor

This month, I was given the chance to play around with a pfSense firewall device, and man, was it awesome.

Consumer networking gear isn't usually all that exciting, but if you're coming from an ISP-supplied router or cheap router/modem combo, then the amount of possible customization in this thing is mind-blowing.

Over in the chip world, I'm curious to see how Intel's Broadwell Iris and AMD's new Carrizo APUs are going to stack up in small Steam streaming machines.

I like the idea of not needing a full tower to play games in the living room. I also like the idea of not needing to buy another discrete GPU just to stream a game.



JIMMY THANG

Online Managing Editor

This year, I finally busted my Computex cherry. I'd always heard that the Taipei tech show was a great event for the DIY PC crowd, but I still left feeling totally blown away.

While shows like E3 and CES do offer plenty of PC coverage, they can also feel slightly ancillary. Computex, on the other hand, wholeheartedly embraces the hardcore PC crowd. It's the premier event for PC components.

I got to see some of the wildest chassis I'd ever seen there (In Win's transforming case, I'm looking at you), along with some of the craziest custom mods on the planet, and much more. Computex is, without a doubt, the definitive show for the PC enthusiast.

Rig of the Month: The Tank

A metal-clad beast fit for virtual battle

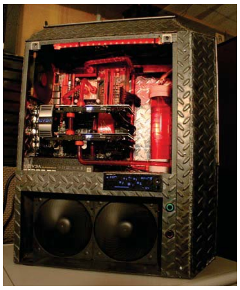
MOST CASES are made of unadorned, powder-coated steel. Some use slightly pricier aluminum, anodized in mundane shades of black and silver. Custom builds, like this month's Tank, take things more than a few steps further. Joe Rivera's metal-clad monster is a one-off machine covered, head-to-toe, in diamond plate. It's a unique look that's sure to attract attention, but we'd hate to have to lug this monster around to LAN parties.

There's no getting past the Tank's tread-covered exterior and that's no surprise since Joe's a metal fabricator by trade. Welds cover every edge of the case and custom grills along the front, bottom, and top keep the case from becoming a toaster.

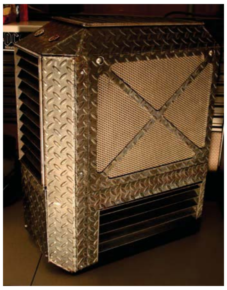
Joe mounted a Lamptron fan controller in the side of the case to have easy access to fan speeds and temperature controls. A special compartment at the bottom holds a 360x80mm radiator that's completely isolated from the system components, to keep things nice and cool.

Underneath the all-metal hood, this computer is powered by a Gigabyte GA Z97X motherboard, an Intel Core i7-4770K CPU, overclocked to 4.4GHz, 16GB of G.Skill RAM, and two EVGA 780 Ti Classifieds, complete with custom backplates.

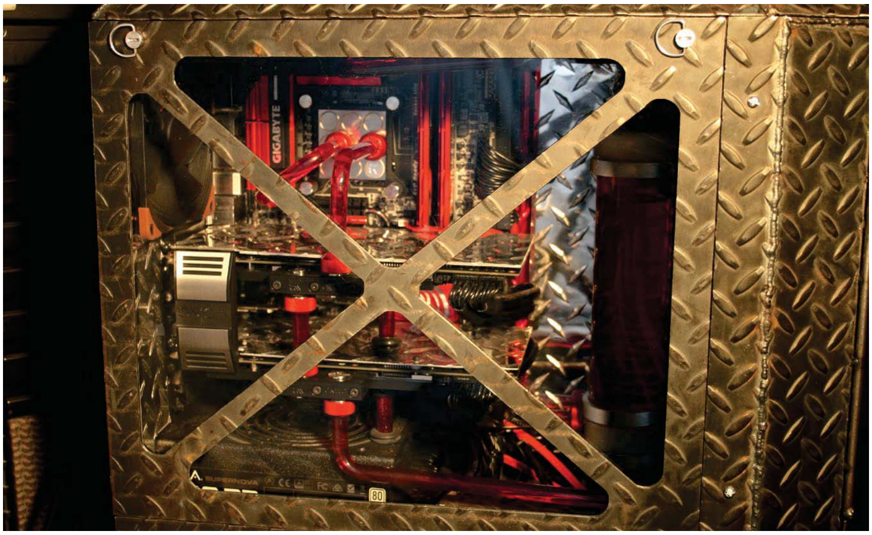
EK waterblocks for the CPU and both of the GPUs are hooked up to a PrimoChill D5 reservoir and a pump to complete the rig's water-cooling loop. **–BK**



The Tank bares all to give us a look into the interior of the case. Diamond plate peeks out from behind the motherboard—even the motherboard tray is made of the stuff—alongside some clean cable management, rigid tubing, and a generous helping of red lighting.



Instead of leaving the back panel open to the mobo tray, Joe opted for a mesh backing to add some medieval flair. It's also a functional, important concession. Mesh also lines the front, top, and bottom grills to keep this entirely metal case from getting too toasty.



This close-up shows off the Tank's good side. The warm lighting detracts from the overall aesthetic, but we're happy to look past any reflections to get a good view of Joe's amazing craftsmanship. The visible welds make it look beefy, and thumbscrews provide easy access.

GEEK TESTED & APPROVED

Ultimate Ears Boom

IN THE PAST FEW YEARS, small, portable Bluetooth speakers have made their way into the consumer electronics market. The Ultimate Ears Boom is the latest player to join the field.

It looks like a large can of Monster Energy covered in a type of mesh, which offers a confident grip in your hand. The Boom keeps it simple with only four buttons—for power, Bluetooth pairing, and two for volume. You can link over 10 Booms together over Bluetooth, too.

It comes with a silicone rubber grommet cap that covers holes for the 3.5mm jack and micro-USB connections on the base. There's also a metal D-ring, so you can easily attach it to a backpack. The Boom is also splash and stain resistant. We tested this by eating cheesy snacks and handling the speaker. Remnants were wiped away easily.

At $200, the Boom sells portability. It delivers with a 15-hour battery and fairly short charging time. The manual includes instructions on how to remove and replace the lithium-ion batteries, which is a nice touch. We also liked how Bluetooth pairing can be initiated with NFC by tapping your device to the speaker. It took a couple of tries, but it was really neat when it finally worked.

Concerning sound, the Boom offers loudness and more clarity than laptop or phone speakers, but don't expect audiophile-grade highs and lows. To be fair, we went to Target and all the portable speakers in this price range left a lot to be desired. With the battery life, water and dirt resistance, and ease of use, we wouldn't mind taking the Boom on a hiking trip or in the workshop. **–AC**

$200, www.ultimateears.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Windows Firewall
> Linux Drivers
> Our New Website

Keep It Safe

I was surprised to read in your "Secure Your Windows 8.1 PC" article (June issue) that you would recommend Windows Firewall. It is, as I've read elsewhere, at best only half a firewall. As stated in the article "... the Windows Firewall blocks almost all incoming connections...." What about outbound connections? If a nasty is able to install, what is to prevent it from "calling home" and further installing additional nasties?

I've been using Zone Alarm Pro for many years with Windows XP, Windows 7, and Windows 8.1, and have found its outbound blocking ability as useful as its inbound blocking ability. Even Zone Alarm Free provides both the inbound and outbound protection not available in Windows Firewall. Windows Firewall is an inferior product for *Maximum PC* to recommend.

—Gerald

EDITOR-IN-CHIEF TUAN NGUYEN RESPONDS: Hi, Gerald. We typically strive to keep our OSes as clean as possible, and try to avoid software that bogs down precious CPU cycles. You're correct to point out that there are third-party tools, such as Zone Alarm, that do a fantastic job of keeping your network traffic under a watchful eye. However, although one could argue that CPUs are powerful enough these days to handle the extra fat, Zone Alarm has grown to be quite heavy in the system resources department. Windows Firewall was a shameful implementation of an OS-level firewall back in the day, but it has come a long way and is now a good and very lightweight option for many. That said, it typically isn't enough for people such as yourself, or even for me. I'd personally recommend that people properly configure their hardware NAT and to use a firewall that has granular controls, such as ports, ranges, DNS filter, and other custom rules lists.

[NOW ONLINE]

ARE YOU BOTTLENECKING YOUR GRAPHICS CARD?

Thinking about upgrading your graphics card? You might want to make sure your CPU won't be a performance bottleneck to your shiny new GPU. How do you know whether your CPU is or will be a hindrance? Our in-depth article takes you through what a bottleneck is, and what happens when it occurs. Then we give you advice on how to determine if your CPU and GPU are well matched for gaming. http://bit.ly/MPC_cpubottle

GEFORCE GTX
GEFORCE GTX

Check for a bottleneck before spending big on a new GPU.

WMC on the Way Out

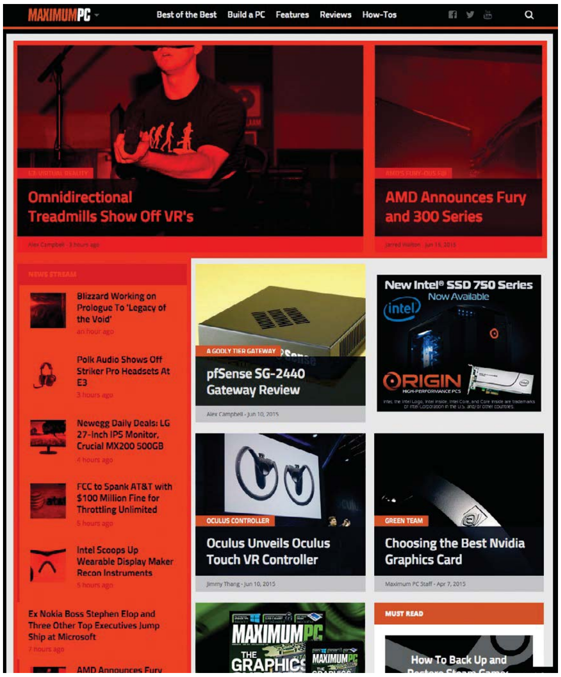
When I signed up for my Windows 10 upgrade, from an automatic prompt in Windows 7, it informed me that Windows Media Center (WMC) is unavailable in Windows 10. What?! Please do an article about how I can mitigate the pain upgrading will cause my HTPC.

Maybe a hack to keep WMC on Win10? A round-up of alternative programs maybe? I may keep hiding in my Win7 bolt hole if there isn't a good replacement, even with the free upgrade.

—James

EDITOR-IN-CHIEF TUAN NGUYEN RESPONDS: Hi, James. That's right. Microsoft is doing away with a barrage of staple Windows features in Windows 10, and Windows Media Center is going the way of the Raphus cucullatus (the dodo bird). Other features, such as games and gadgets, are

↘ submit your questions to: comments@maximumpc.com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being ditched as well. Another thing to note is the ability to control what upgrades Windows will download and install. For Windows 10 Home Edition, you'll have no ability to control what updates are installed and when. The only way you'll get to maintain control is to pay to move to Windows 10 Professional. We'll see if we can find a way to keep Windows Media Center when Windows 10 officially arrives.

Build Dreams

I have now, with my latest rig, built my thirtieth desktop. It's a good way for a high school student to earn money. I'm now bored with building desktops and want to try building a gaming laptop, but unfortunately, there aren't any guides. Plus, finding a gaming (or any other) laptop motherboard or screen (preferably 4K) has proven a real pain. Could you please feature a guide on building a laptop? **—Kostya**

ONLINE MANAGING EDITOR JIMMY THANG RESPONDS: Hi, Kostya. We don't want to say that it can never be done, but for all intents and purposes, it can't. Sure, if you're Tony Stark and are super technical and have tons of cash to play around with, maybe. But even then, you would most likely be purchasing a bare-bones unit, which will have you sticking in the same components as a "prebuilt." Laptop components are often custom-made for a certain type of chassis and there isn't a big open standard like there is with, say, ATX form factors. You also won't be saving money, so it doesn't make any sense to try and buy the parts piecemeal yourself.

On the bright side, many hardware OEMs offer a decent amount of customization options that will allow you to choose everything from your monitor resolution to your processor. You'll also often be able to upgrade the RAM and storage in these laptops, as need be. In the meantime, unless you're maniacal, we suggest you save your time, money, and breath before trying to build a gaming laptop yourself.

Somebody Call FEMA

The new *Maximum PC* website is an unmitigated disaster. Nothing but visual noise, no pattern or obvious flow. I can't find anything without endless searching, hard to look at, let alone enjoy.

Sometimes, newer isn't better, and this proves the point. I used to check it out every day, but now I avoid it whenever I can. As a long-time subscriber to the magazine, I used to think of the site like a bonus-add, now it's making me question my subscription and my loyalty. Go back to the "old-fashioned" look. **—Garvin**

EDITOR-IN-CHIEF TUAN NGUYEN RESPONDS: Hi, Garvin. In actuality, the old *Maximum PC* website still exists on the new site. The contents of the front page of the old site is contained in the new site's home slider plus the left-hand news column (see the screenshot, above).

That's pretty much what the front-page contents was, and that's how we implemented it on the new site. It's all still there. The other columns are for articles we feel are worth a read, so they get promoted to those areas. I agree that sometimes the old-fashioned way of doing things is best, but I really believe the new site shows off our content better—especially now that we're putting out a lot more on a day-to-day basis. ⏻

Facebook Polls

Best Budget Build

A friend asks you to build a kick-ass but budget gaming rig—what components do you put inside? Here's what some of our Facebook buddies would build.

Tom Londy Lowest budget, AMD CPU. Higher, i5. Even higher, i7. From there, 8GB RAM, at least a 600W PSU, GPU maybe a GTX 960.

Mike Blaszczak: I tell them to buy a Dell. I'm not getting stuck supporting that thing.

Terry Matthews: An AMD FX-8350, Asus M5A97 R2.0, 8GB Corsair or G.Skill RAM, GTX 750 Ti, 750W PSU, $80 case, and Win7 Pro.

Tom Martin: For a good budget rig, I would start with a 990FX mobo and an FX-8350.

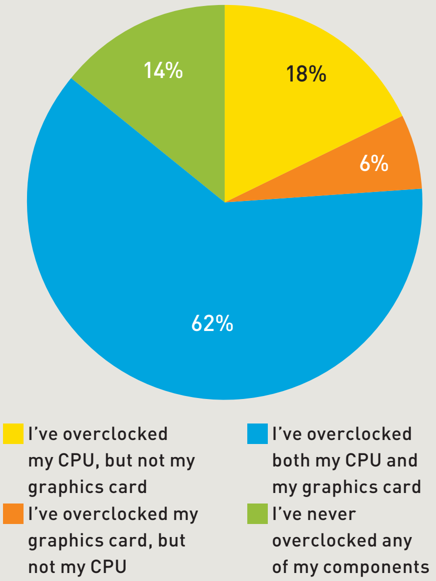
Rick Holzheuer: I would use an i5 chip and 8GB of RAM (Crucial preferred), Samsung SSD for better performance and a decent GeForce video card to meet the budget.

Nathaniel Rae: GTX 760, PSU with enough juice to upgrade later, 8GB 2,400MHz RAM, i5 at 3.2GHz at least. If shopped smart, it can be had for just over $700.

Johnny Sammour: Here's a $350 build: Intel Pentium G3450 (Haswell refresh), a cheap motherboard (there are a lot of them), GTX 750 Ti, 1TB HDD, case with power supply included.

Josh Hust: A processor that isn't supported by a bunch of whiny fanboys who continually go on the competition's pages to talk trash. Intel guys, I'm looking at you.

How much overclocking have you done?



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THE BUILDS

BUDGET GAMER

INGREDIENTS

PART		PRICE
Case	NZXT Source 210 Elite	$47
PSU	Corsair CX500M 500W	$60
Mobo	Gigabyte GA-Z97-HD3 (R2)	$100
CPU	Intel Core i3-4150	$123
GPU	MSI GTX 960 GAMING 4G GeForce GTX 960	$240
RAM	2x 4GB G.Skill Ripjaws (red) DDR3/1600 **NEW**	$55
SSD	240GB SanDisk Ultra II	$110
HDD	Seagate Barracuda 1TB **NEW**	$52
OS	Ubuntu Desktop Linux 14.04 LTS 64-bit	$16

Approximate Price: $803

PRICES ON VARIOUS parts crept up since last month, so we decided to drop the storage capacity down to 1TB on the spinning drive. While this puts a little more of a squeeze on the PC's archival abilities, the cloud (our least-favorite buzzword) can be used for storage of things like photos. If the cloud isn't your idea of a fluffy paradise world, external HDDs are getting cheaper, so you could always buy one down the road if the need arises. We also swapped out the Ballistix for a pair of Ripjaws, as the Ripjaws have solid timings and identical voltages for about the same price. Plus, they're red. A little splash of color never hurt anybody.

MIDRANGE

INGREDIENTS

PART		PRICE
Case	Corsair Vengeance C70	$120
PSU	EVGA SuperNOVA G2 850W	$150
Mobo	Asus Z97-A/USB 3.1	$155
CPU	Intel Core i5-4690K	$240
Cooler	Corsair H100i **NEW**	$100
GPU	Sapphire 100362-3L Radeon R9 290 4G **NEW**	$280
RAM	2x 4GB Crucial Ballistix Sport DDR3/1600	$50
Optical Drive	Samsung SH-224DB/BEBE	$20
SSD	2x Mushkin Enhanced ECO2 120GB	$106
HDD	Seagate Barracuda 3TB ST3000DM001	$90
OS	Windows 8.1 64-bit OEM	$100

Approximate Price: $1,411

THE H100i GT we previously had went up in price, so we switched for its smaller sibling, the H100i. It's almost identical, but has a slightly smaller rad, which can make for an easier install, and will allow more options if you switch case. For the GPU, we stuck with team red, but are holding off on entering the 300 series. The new crop of Radeons are almost the same as the 200 series, but with more RAM and slightly higher clocks. Those features result in a 390 that's about $100 more than the 290 for few obvious advantages. We'll see how prices pan out over the next few months. Sapphire's version of the 290 was chosen due to price hikes for XFX's implementation.

TURBO

THIS MONTH, we just couldn't resist placing a GTX 980 Ti in the Turbo system. The card is only $50 more than the 295X2 we had in its place last month, with lower power consumption and performance only bested by the Fury X and Titan X. EVGA advertises a 20 percent reduction in GPU temps with its solution, but you can find reference models for as low as $650. The 980 Ti's power draw is only 250W, half that of the 290X2. That lets us get away with a much smaller power supply. We saved quite a bit of coin by going with the 850W SuperNOVA. Even then, we left a little headroom for possible moderate overclocks and the addition of a few more drives. With the saved cash, we were able to go with a Western Digital Black drive instead of the Seagate Barracuda. The Western Digital comes with a five-year warranty, which sells us on the drive's longevity.

For more of our component recommendations,
visit www.maximumpc.com/best-of-the-best.

INGREDIENTS

PART			PRICE
Case	Corsair Graphite 780T		$180
PSU	EVGA SuperNOVA G2 850W	NEW	$140
Mobo	Asus X99-PRO/USB 3.1		$340
CPU	Intel Core i7-5820K		$390
Cooler	Cooler Master Nepton 280L		$120
GPU	EVGA GeForce GTX 980 Ti 6GB	NEW	$670
RAM	4x 4GB Corsair Vengeance LPX DDR4/2400		$170
Optical Drive	LG Blu-ray Burner WH16NS40		$59
SSD	2x 500GB Samsung 850 EVO		$400
HDD	3TB WD Black	NEW	$150
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $2,719

UPGRADE OF THE MONTH

GEFORCE GTX 980 TI

The GeForce 980 Ti is the Titan X's little brother and definitely holds its own in the latest games. Both the Fury X and the Titan X offer more performance, but the Fury X has a bigger footprint with its attached radiator, despite the small size of the card. The Titan X is still over $1,000 per card, making the 980 Ti the Titan for those with shallower pockets.

$650, www.geforce.com

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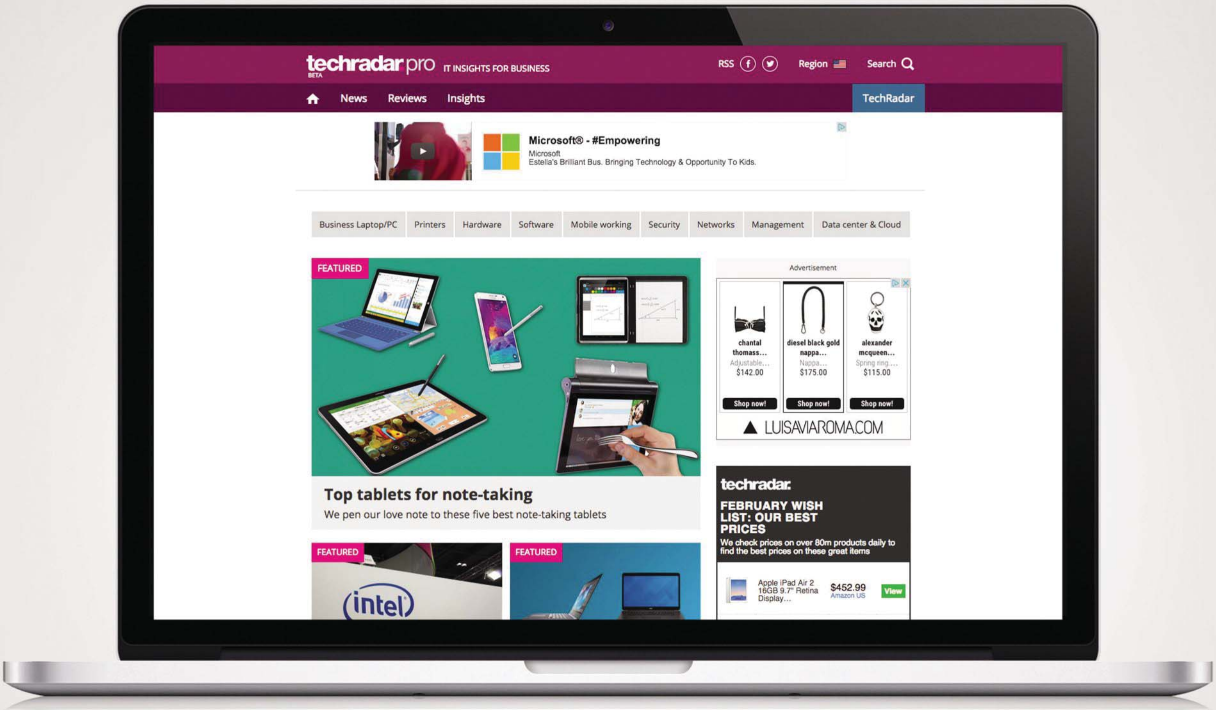
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